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Atlas of Cloud-Free Line-of-Sight Probabilities

Part 3: United States of America

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METEOROLOGY DIVISION PROJECT 8624
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AIR FORCE SYSTEMS COMMAND, USAF

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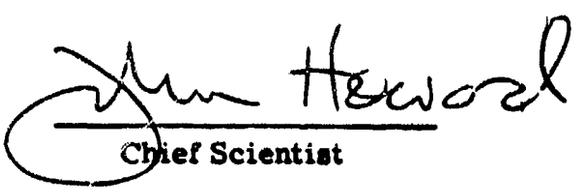

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This is the third part of a planned Northern Hemisphere atlas of probabilities of cloud-free lines-of-sight between the earth and space. The probabilities are for the mid-season months: January, April, July, and October; four times of day: 0000-0200 LST, 0600-0800 LST, 1200-1400 LST, and 1800-2000 LST; and three elevation angles: 10°, 30°, and 90°. Parts 1 and 2 depicted cloud-free line-of-sight probabilities for Germany and the USSR respectively.

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1. INTRODUCTION

The increased use of optical, infrared, and microwave observing and transmitting devices has resulted in a greater demand for information on humidity, haze, clouds, and precipitation. The Air Force Geophysics Laboratory (AFGL)* Climatology and Dynamics Branch (LYD), Hanscom AFB, MA 01731, and the USAF Environmental Technical Applications Center (ETAC)*, Scott AFB, Illinois 62225, have responded to this demand by collecting special observations, developing models for estimating the desired information in the absence of direct observations, and processing vast quantities of data.

One of the items frequently requested is information on the probability of a cloud-free line-of-sight (CFLOS) between a specific point on the surface of the earth and an aircraft or an object in space. A large volume of data has been processed in response to these requests.

AFGL and ETAC are endeavoring to prepare a Northern Hemisphere atlas from these data. Because this is a very time-consuming effort, we have decided to prepare the atlas in parts as data become available. The first and second

(Received for publication 24 August 1977)

*Department of Defense organizations and contractors are encouraged to contact AFGL or ETAC for additional information on line-of-sight probabilities. Persistence, recurrence, joint probabilities, and probabilities as a function of altitude are available.

parts depicting CFLOS probabilities over Germany[1] and the USSR[2] have been published.

2. THE MODEL

Lund and Shanklin[3] developed models for estimating probabilities of CFLOS through the atmosphere at any desired elevation angle and geographical location. The models require a knowledge of sky-cover climatology for the locations.

The model used to estimate CFLOS probabilities through the entire atmosphere can be expressed as follows:

$$ {}_{\alpha}\hat{P}_1 = {}_{\alpha}C_s K_1 \qquad (1) $$

where ${}_{\alpha}\hat{P}_1$ is a column vector of α rows, one row for each angle considered, ${}_{\alpha}C_s$ is a matrix of α rows and s columns, one column for each sky cover category, and ${}_{s}K_1$ is a column vector of s rows. The $\hat{P}$ values are estimates of CFLOS probabilities, the C values are CFLOS probabilities at angle α given k tenths of cloudiness, and the K values are probabilities of each k tenths of cloudiness.

The ${}_{\alpha}C_s$ matrix used for this paper is given in Table 1.

Table 1. Probabilities of Cloud-Free Lines-of-Sight as a Function of Elevation Angle and Observed Total Sky Cover in Tenths. This is the ${}_{\alpha}C_s$ Matrix

Elevation Angle (degrees)	Sky Cover (tenths)										
	0	1	2	3	4	5	6	7	8	9	10
90	1.00	0.97	0.92	0.87	0.81	0.77	0.70	0.62	0.48	0.31	0.08
30	0.98	0.93	0.86	0.80	0.73	0.66	0.57	0.50	0.38	0.24	0.06
10	0.97	0.86	0.76	0.65	0.55	0.47	0.39	0.32	0.24	0.16	0.03

1. Lund, I. A., Grantham, D. D., and Elam, C. B., Jr. (1975) Atlas of Cloud-Free Line-of-Sight Probabilities, Part 1: Germany, AF Surveys in Geophysics No. 309, AFCRL-TR-75-0261, 77 pp.

2. Lund, I. A., Grantham, D. D., and Elam, C. B., Jr. (1976) Atlas of Cloud-Free Line-of-Sight Probabilities, Part 2: Union of Soviet Socialist Republics; AF Surveys in Geophysics No. 358, AFGL-TR-77-0005, 63 pp.

3. Lund, I. A., and Shanklin, M. D. (1973) Universal methods for estimating probabilities of cloud-free lines-of-sight through the atmosphere, J. Appl. Meteorol. 12(No. 1):28-35.

3. AN EXAMPLE

The climatic record of sky cover at Minneapolis, Minnesota, shows that 0/10, 1/10, ..., 9/10, and 10/10 sky cover was reported 22.3, 4.8, 3.4, 2.2, 1.5, 2.4, 3.1, 3.7, 5.2, 5.3, and 46.1 percent of the time, respectively, between 1200-1400 LST during January 1946 through 1970. Performing the matrix multiplication, we obtain:

$$ {}_{\alpha}P_1 = \begin{bmatrix} 1.00 & 0.97 & ..... & 0.31 & 0.08 \\ 0.98 & 0.92 & ..... & 0.24 & 0.06 \\ 0.97 & 0.84 & ..... & 0.16 & 0.03 \end{bmatrix} \begin{bmatrix} 0.223 \\ 0.048 \\ . \\ . \\ 0.053 \\ 0.461 \end{bmatrix} = \begin{bmatrix} 0.474 \\ 0.433 \\ 0.376 \end{bmatrix} \quad (2) $$

The computations show that there is a 47.4 percent probability of a CFLOS at Minneapolis looking toward the zenith (90°), and a 43.3 percent and 37.6 percent probability of a CFLOS at 30° and 10° elevation angles, respectively.

4. THE STATIONS

Table 2 lists stations from which long records of hourly sky cover observations are available. CFLOS probabilities were computed for these stations, which are shown in Figure 1.

5. THE ANALYSIS

A total of 51 maps are included in this paper: one station locator map, Figure 1; one map for each of the four mid-season months (January, April, July, October) covering four 3-hr periods (0000-0200 LST, 0600-0800 LST, 1200-1400 LST, 1800-2000 LST), and three elevation angles (10°, 30°, 90°), Figures 2 through 49; and two maps depicting the extreme conditions (that is, the highest and the lowest probability for any of the above months and periods), Figures 50 and 51. In order to conserve space, the extreme condition is shown for the 30° elevation angle only.

Eq. (1) was used to compute CFLOS probability values. The ${}_{g}K_1$ column vector was changed with every station, month, or 3-hr time period. For the majority of U.S.A. stations, the probabilities were based on more than 1300 sky-cover observations (that is, at least a 15-yr period-of-record). The probability values were plotted on maps and analyzed as shown in Figures 2 through 51. Be-

cause the isolines were drawn strictly to the data, the analysis seldom departs more than 2 or 3 percent from the computed probabilities. Terrain features were not specifically considered in the analysis but their effects are obvious, as seen along the west coast of California and in the desert areas of southwestern U.S.A.

The data coverage over much of Canada, some coastal and mountain areas, and all offshore areas, is too sparse for accurate, detailed analysis. If the location of interest is not close to a station used in the analysis, the user of this atlas may wish to consult other data sources for additional cloud cover data and compute cloud-free line-of-sight probabilities using Eq. (1). The analysis was not extended into the Caribbean Islands. CFLOS probability values are plotted for Eleuthera Island (2), Grand Turk Island (3), and Guantanamo Bay, Cuba (4).

The CFLOS atlas for Germany, Part 1 of this series, included probabilities for the 50° elevation angle. They are not included in this paper because more than 97 percent of the time they range from 1 to 2.5 percent less than corresponding probabilities for the 90° elevation angle. The 50° elevation angle probabilities were always at least 1 percent less than the 90° probabilities but never more than 3.5 percent less. Probabilities for the 50° elevation angle should be estimated by subtracting 2 percent from the 90° probabilities

Table 2. Station Locator

WMO Number (Call Letters)		State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
		Alabama					
72323	HSV		1	Huntsville CAA-WBAS	34-39	86-46	192
	SEM		2	Selma/Craig AFB	32-20	86-59	50
	MXF		3	Montgomery/Maxwell AFB	32-23	86-22	52
	OZR		4	Fort Rucker/Cairns AFB	31-16	85-43	93
	BFM		5	Mobile/Brookley AFB	30-38	88-04	8
		Arizona					
72384	INW		1	Winslow WFAS	35-01	110-43	1505
	LUF		2	Phoenix/Luke AFB	33-33	112-22	336
	CHD		3	Chandler/Williams AFB	33-18	111-40	422
72280	YUM		4	Yuma MAP	32-39	114-37	55
	DMA		5	Tucson/Davis Monthan AFB	32-10	110-53	824
72274	TUS		6	Tucson IAP	32-07	110-57	802
72373	FHU		7	Fort Huachuca/SIG CORPS [illegible]	31-35	110-20	1422
	DYE	Arkansas	1	Bigbeville AFB	35-58	93-57	78
72344	FSM		2	Fort Smith	35-20	94-22	143
	LRF		3	Jacksonville/Little Rock AFB	34-57	92-09	95
		California					
	SIY		1	Montague FAA/Siskiyou Cny Apt.	41-47	122-28	807
	[illegible]		2	Blue Canyon Apt.	39-17	120-43	1611
	BAB		3	Beale AFB	39-08	121-26	34
			4	Donner Summit, CAA	39-19	120-20	2193
	MCC		5	Sacramento/McClellan AFB	38-40	121-24	23
	MHR		6	Sacramento/Mather AFB	38-34	121-18	20
74516	SUU		7	Fairfield/Travis AFB	38-16	121-56	19
	SRF		8	San Rafael/Hamilton AFB	38-04	122-30	1
74506	NGZ		9	Alameda NWSF	37-47	122-19	5
72494	SFO		10	San Francisco WBAS	37-37	122-23	3
74509	NUQ		11	Sunnyvale/Moffett Fld, NWSED	37-25	122-03	10
72481	MER		12	Merced/Castle AFB	37-23	120-34	57
	OAR		13	Fort Ord/Fritzsche AAF	36-41	121-46	41
72491	NSU		14	Monterey NWSED	36-35	121-51	74
72389	FAT		15	Fresno/Air Terminal WBAS	36-46	119-43	101
74702	NLC		16	Lemoore NWSED	36-20	119-57	72

Table 2. Station Locator (Cont)

WMO Number	(Call Letters)	State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Latitude (m)
74612	NID	California (Cont)	17	China Lake/Inyokern NAF	35-41	117-41	696
72393	VBG		18	Vandenberg AFB	34-43	120-34	112
72381	EDW		19	Edwards AFB	34-54	117-52	702
	VCV		20	Victorville/George AFB	34-35	117-23	876
	CAF		21	Oxnard AFB	34-13	119-05	29
72391	NTD		22	Point Mugu PMR	34-07	119-07	4
	NTB		23	Los Alamitos NWSED	33-48	118-03	8
72295	LAX		24	Los Angeles WBAS	33-57	118-24	38
	ONT		25	Ontario WB 2nd ORD	34-03	117-36	290
	SBD		26	San Bernardino/Norton AFB	34-06	117-14	352
72380	EED		27	Needles FAA	34-46	114-37	302
	NTK		28	Santa Ana MCAS	33-48	117-50	60
	NZJ		29	El Toro MCAS	33-40	117-44	117
72286	RIV		30	Riverside/March AFB	33-54	117-15	467
72291	NSI		31	San Nicolas Island PMR	33-14	119-28	154
	NUC		32	San Clemente Island NAS	33-01	118-35	55
	NKX		33	Miramar NWSED	32-52	117-09	147
	NZY		34	San Diego FWC	32-42	117-11	
	NRS		35	Imperial Bch/Ream Fld. NWSED	32-34	117-07	8
72281	NJK		36	El Centro NAAS	32-49	115-40	-13
		Colorado					
	BKF		1	Aurora/Buckley Fld. Ang.	39-42	104-45	1726
72476	GJT		2	Grand Junction City Cnty Apt.	39-07	108-31	1480
72466	COS		3	Colorado Springs/Peterson Fld.	38-49	104-43	1881
72468	FCS		4	Fort Carson/Butts AFB	38-41	104-46	1779
72464	PUB		5	Pueblo/Memorial Apt.	38-17	104-30	1440
	LHX		6	La Junta MAP	38-03	103-31	1292
		Connecticut					
72508	BDL		1	Windsor Locks/Bradley Fld.	41-56	72-41	53
	HVN		2	New Haven	41-16	72-53	4
72504	BDR		3	Bridgeport	41-10	73-08	3
		Delaware					
	DOV		1	Dover AFB	39-08	75-28	9

Table 2. Station Locator (Cont)

WMO Number	(Call Letters)	State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
		Florida					
72206	JAX		1	Jacksonville WBAS	30-30	81-41	9
	NRB		2	Mayport NWSED	30-24	81-25	6
	NIP		3	Jacksonville NAS	30-14	81-41	7
	NZC		4	Jacksonville/Cecil Fld. NAS	30-13	81-53	24
	NSE		5	Milton/Whiting Fld. NWSED	30-44	87-01	61
72221	VPS		6	Valparaiso/Eglin AFB	30-29	86-31	26
74777	HRT		7	Valparaiso/Hurlburt Fld. /EGL 9	30-26	86-41	11
	NUN		8	Pensacola/Saufley Fld. NAAS	30-28	87-20	26
72214	TLH		9	Tallahassee	30-24	84-21	25
74775	PAM		10	Panama City/Tyndall AFB	30-04	85-35	6
72205	MCO		11	Orlando/McCoy AFB	28-26	81-19	32
74794	XMR		12	Cape Kennedy AFS	28-29	80-34	3
74795	COF		13	Cocoa Beach/Patrick AFB	28-14	80-36	3
74788	MCF		14	Tampa/MacDill AFB	27-51	82-31	4
74796	AGR		15	Avon Park Range AAF	27-38	81-20	21
72202	MIA		16	Miami IAP	25-48	80-17	3
	HST		17	Homestead AFB	25-29	80-24	2
72201	EYW		18	Key West	24-33	81-46	1
		Georgia					
72227	MGE		1	Marietta/Dobbins AFB	33-55	84-31	326
72218	AGS		2	Augusta	33-22	81-58	44
	WRB		3	Warner Robins/Robins AFB	32-38	83-36	90
72225	LSF		4	Fort Benning/Lawson AAF	32-21	85-00	71
	SVN		5	Savannah/Hunter AAF	32-01	81-08	13
	TRF		6	Albany/Turner AFB	31-35	84-07	66
	NEA		7	Brunswick/Glynco NWSED	31-15	81-28	8
	VAD		8	Valdosta/Moody AFB	30-58	83-12	71
		Idaho					
72681	BOI		1	Boise WBAS	43-34	116-14	871
	MUO		2	Mountain Home AFB	43-03	115-52	913
		Illinois					
	NBU		1	Glenview NWSF	42-05	87-49	199
72530	ORD		2	Chicago/Ohare Fld. WBAS	41-59	87-54	203

Table 2. Station Locator (Cont)

WMO Number (Call Letters)	State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
72544 MLI	Illinois (Cont)	3	Moline	41-27	90-31	180
72531 RAN		4	Rantoul/Chanute AFB	40-18	88-08	225
BLV		5	Belleville/Scott AFB	38-33	89-51	138
	Indiana					
72533 FWA		1	Ft. Wayne	40-59	85-11	244
GUS		2	Peru/Grissom AFB	40-39	86-09	248
72438 IND		3	Indianapolis	39-44	86-17	243
BAK		4	Columbus/Bakalar AFB	39-16	85-54	200
	Iowa					
72557 SUX		1	Sioux City IAP	42-24	96-23	334
72546 DSM		2	Des Moines WBAS	41-32	93-40	292
	Kansas					
72465 GLD		1	Goodland/Renner Fld.	39-22	101-42	1115
FLV		2	Fort Leavenworth/Sherman AAF	39-22	94-55	235
72455 FRI		3	Fort Riley/Marshall AAF	39-03	96-46	324
FOE		4	Topeka/Forbes AFB	38-57	95-40	324
SSH		5	Salina/Sheilling AFB	38-48	97-38	383
72451 DDC		6	Dodge City	37-46	99-58	791
IAB		7	Wichita/McConnell AFB	37-37	97-16	418
	Kentucky					
FTK		1	Fort Knox/Godman AAF	37-54	85-58	230
74671 HOP		2	Fort Campbell/Campbell AFB	36-40	87-29	174
	Louisiana					
BAD		1	Shreveport/Barksdale AFB	32-30	93-40	51
74754 AEX		2	Alexandria/England AFB	31-20	92-33	27
POE		3	Fort Polk AAF	31-03	93-11	101
NBG		4	New Orleans/Callender NAS	29-50	90-01	2
	Maine					
LIZ		1	Limestone/Loring AFB	46-57	67-53	227
72607 BGR		2	Bangor/Dow AFB	44-48	68-50	59
74392 NHZ		3	Brunswick NWSED	43-54	69-56	23

Table 2. Station Locator (Cont)

WMO Number (Call Letters)		State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
		Maryland					
	FME		1	Fort Meade/Tipton AAF	39-05	76-46	46
74594	ADW		2	Washington, D.C./Andrews AFB	38-49	76-52	85
72404	NHK		3	Patuxent River NWSED	38-17	76-25	12
		Massachusetts					
	AYE		1	Fort Devens AAF	42-34	71-36	82
74490	BED		2	Bedford/LG Hanscom Fld.	42-28	71-17	41
72509	BOS		3	Boston WBAS	42-22	71-00	6
	NZW		4	South Weymouth NWSED	42-09	70-56	49
74491	CEF		5	Chicopee Falls/Westover AFB	42-12	72-32	75
	FMH		6	Otis AFB/Falmouth	41-39	70-31	40
		Michigan					
72744	CMX		1	Houghton County Apt.	47-10	88-29	333
	SAW		2	Gwinn/K I Sawyer AFB	46-21	87-24	372
	INR		3	Kinross/Kincheloe AFB	46-15	84-28	244
72639	APN		4	Alpena WBAS	45-05	83-34	210
	OSC		5	Oscoda/Wurtsmith AFB	44-27	83-24	193
72635	GRR		6	Grand Rapids	42-53	85-31	242
	MTC		7	Mount Clemens/Selfridge AFB	42-36	82-50	178
		Minnesota					
72747	INL		1	International Falls IAP	48-34	93-24	360
72745	DLH		2	Duluth IAP	46-50	92-11	436
72655	STC		3	St. Cloud/Whitney MAP	45-33	94-04	312
72658	MSP		4	Minneapolis/St. Paul IAP	44-53	93-13	256
		Mississippi					
	CBM		1	Columbus AFB	33-39	88-27	67
	MMM		2	Meridan NWSED	32-33	88-34	97
	BIX		3	Biloxi/Keesler AFB	30-25	88-55	8
		Missouri					
72445	COU		1	Columbia Regional Apt.	38-49	92-13	271
	GVW		2	Richards Gebour AFB/Grandview	38-51	94-33	332

Table 2. Station Locator (Cont)

WMO Number (Call Letters)		State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
	SZL	Missouri (Cont)	3	Knoenoster/Whiteman AFB	38-43	93-33	265
	TBN		4	Fort Leonard Wood/Forney AAF	37-45	92-09	353
		Montana					
	GSG		1	Glasgow AFB	48-25	106-32	841
	GFA		2	Great Falls/Malmstrom AFB	47-30	111-11	1074
72775	GTF		3	Great Falls IAP	47-29	111-22	1119
72773	MSO		4	Missoula/Johnson Bell Fld.	46-55	114-05	976
72677	BIL		5	Billings/Logan Fld.	45-48	108-32	1099
		Nebraska					
72562	LBF		1	North Platte	41-08	100-42	847
72554	OFF		2	Omaha/Offutt AFB	41-07	95-54	319
		Nevada					
72583	WMC		1	Winnemucca	40-54	117-48	1311
	RAA		2	Reno/Stead AFB	39-40	119-50	1341
	NFL		3	Fallon NWSED	39-25	118-42	1199
72436	ELY		4	Ely/Yelland Fld.	39-18	114-51	1907
72485	TPH		5	Tonopah FAA MAP	38-04	117-05	1654
	LSV		6	Las Vegas/Nellis AFB	36-15	115-02	569
		New Hampshire					
	PSM		1	Portsmouth/Pease AFB	43-05	70-49	31
		New Jersey					
	WRI		1	Wrightstown/McGuire AFB	40-01	74-36	41
72409	NEL		2	Lakehurst NWSED	40-02	74-21	31
72407	ACY		3	Atlantic City WBAS	39-27	74-35	23
		New Mexico					
	FMN		1	Farmington FAA	36-44	108-14	1677
72365	ABQ		2	Albuquerque IAP	35-03	106-36	1631
	CVS		3	Clovis/Cannon AFB	34-23	103-19	1309
	RSW		4	Roswell/Walker AFB	33-18	104-32	1110
	HMN		5	Alamogordo/Holloman AFB	32-51	106-06	1248

Table 2. Station Locator (Cont)

WMO Number (Call Letters)		State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
		New York					
	PBG		1	Plattsburgh AFB	44-39	73-28	72
	RME		2	Rome/Griffiss AFB	43-14	75-24	154
72519	SYR		3	Syracuse/Hancock IAP	43-07	76-06	128
	IAG		4	Niagara Falls MAP	43-06	78-57	180
	SWF		5	Newburgh/Stewart AFB	41-30	74-06	143
	FOK		6	Westhampton Bch./Suffolk Co. AFB	40-51	72-38	1014
72503	LGA		7	New York/La Guardia	40-47	73-52	6
74486	JFK		8	New York/J.F. Kennedy IAP WBAS	40-38	73-47	4
		North Carolina					
	ECG		1	Elizabeth City/USCG Air Stn.	36-16	76-11	4
72317	GSO		2	Greensboro	36-06	79-57	282
72304	HAT		3	Cape Hatteras WBO	35-16	75-33	3
	GSB		4	Goldsboro/Seymour Johnson AFB	35-20	77-58	33
	FAY		5	Fayetteville/Pope AFB	34-59	78-53	57
74693	FBG		6	Fort Bragg/Simmons AAF	35-08	78-56	74
72309	NKT		7	Cherry Point MCAS	34-54	76-53	9
	NCA		8	Jacksonville/New River MCAF	34-42	77-26	8
	ILM		9	Wilmington WBO WBAS	34-16	77-54	9
		North Dakota					
	MIB		1	Minot AFB	48-25	101-21	508
72767	ISN		2	Williston/Sloulin Fld. IAP	48-11	103-38	597
	RDR		3	Grand Forks AFB	47-57	97-24	277
72753	FAR		4	Fargo WBO WBAS	46-55	96-49	274
72764	BIS		5	Bismarck MAP	46-47	100-45	511
		Ohio					
72536	TOL		1	Toledo	41-35	83-48	208
72524	CLE		2	Cleveland	41-25	81-51	241
74570	FFO		3	Dayton WP AFB/Patterson Fld.	39-49	84-03	251
	LCK		4	Columbus/Lockbourne AFB	39-49	82-56	227
	ILN		5	Wilmington/Clinton Co. AFB	39-26	83-48	327

Table 2. Station Locator (Cont)

WMO Number	(Call Letters)	State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
		Oklahoma					
	END		1	Enid/Vance AFB	36-21	97-55	398
	CSM		2	Clinton Sherman AFB	35-20	99-12	586
72354	TIK		3	Oklahoma City/Tinker AFB	35-25	97-23	393
72355	FSI		4	Fort Sill/Post Fld.	34-39	98-24	362
72352	LTS		5	Altus AFB	34-40	99-16	420
		Oregon					
72791	AST		1	Astoria WBO WBAS	46-10	123-53	3
72698	PDX		2	Portland IAP	45-35	122-36	8
72693	EUG		3	Eugene	44-07	123-13	111
72683	4BW		4	Burns WSMO	43-35	119-03	1271
72597	MFR		5	Medford	42-22	122-52	406
	LMT		6	Klamath Falls/Kingsley Fld.	42-09	121-44	1247
		Pennsylvania					
72526	ERI		1	Erie IAP	42-05	80-11	223
72514	IPT		2	Williamsport	41-15	76-55	161
72520	PIT		3	Pittsburgh/Grtr. Pittsburg WBAS	40-30	80-14	366
	MDT		4	Middletown/Olmstead AFB	40-12	76-46	94
	NXX		5	Willow Grove NWSED	40-12	75-09	113
		Rhode Island					
	NCO		1	Quonset Point NWSED	41-36	71-25	7
		South Carolina					
74790	SSC		1	Sumter/Shaw AFB	33-58	80-28	77
	MMT		2	Eastover/Mc Entire Ang	33-55	80-48	77
74791	MYR		3	Myrtle Beach	33-41	78-56	8
72208	CHS		4	Charleston WBAS	32-54	80-02	14
	NBC		5	Beaufort MCAS	32-29	80-43	12

Table 2. Station Locator (Cont)

WMO Number (Call Letters)		State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
		South Dakota					
	PIR		1	Pierre MAP	44-23	100-17	531
	RCA		2	Rapid City/Ellsworth AFB	44-08	103-06	999
72651	FSD		3	Sioux Falls WBAS	43-35	96-44	435
		Tennessee					
	TRI		1	Bristol	36-29	82-24	463
	SYM		2	Smyrna/Sewart AFB	86-00	86-32	273
	NQA		3	Memphis NWSED	35-21	89-52	98
72324	CHA		4	Chattanooga	35-02	85-12	208
		Texas					
72363	AMA		1	Amarillo/English Fld. WBAS	35-14	101-43	1099
72351	SPS		2	Wichita Falls/Sheppard AFB	33-59	98-30	309
	FNX		3	Sherman/Perrin AFB	33-42	96-41	230
	REE		4	Lubbock/Reese AFB	33-36	102-03	1017
	CWO		5	Mineral Wells/Fort Walters AAF	32-50	98-00	272
	FWH		6	Fort Worth/Carswell AFB	32-47	97-26	198
	NBE		7	Dallas NWSED	32-44	96-58	151
	DYS		8	Abilene/Dyess AFB	32-26	99-51	546
	BGS		9	Big Spring/Webb AFB	32-13	101-31	781
	BIF		10	El Paso/Biggs AFB	31-50	106-24	1196
	WAO		11	Waco/James Connally AFB	31-38	97-04	145
72263	SJT		12	San Angelo/Mathis Fld. WBAS	31-22	100-30	584
	HLR		13	Fort Hood/Fort Hood AAF	31-09	97-43	281
	BSM		14	Austin/Bergstrom AFB	30-13	97-40	165
	RND		15	San Antonio/Randolf AFB	29-32	98-17	232
	SKF		16	San Antonio/Kelley AFB	29-23	98-35	210
	HDO		17	Hondo AAF	29-21	99-11	283
	DLF		18	Del Rio/Laughlin AFB	29-22	100-47	329
	EFD		19	Houston/Ellington AFB	29-37	95-10	12
	NIR		20	Beeville/Chase Fld. NWSED	28-22	97-40	58
	NGP		21	Corpus Christi NWSED	27-42	97-17	6
	NQI		22	Kingsville NWED	27-30	97-49	15
72252	LRD		23	Laredo AFB	27-32	99-27	155

Table 2. Station Locator (Cont)

WMO Number (Call Letters)		State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
		Utah					
	HIF		1	Ogden/Hill AFB	41-07	111-58	1459
	DPG		2	Dugway PG/Michales AAF	40-12	112-56	1326
	HVE		3	Hanksville FAA	38-25	110-42	1355
	BCE		4	Bryce Canyon FAA	37-42	112-10	2312
		Vermont					
72617	BTV		1	Burlington WBAS	44-28	73-09	102
		Virginia					
72403	IAD		1	Washington, D.C./Dulles IAP	38-57	77-27	95
	DAA		2	Fort Belvoir/Davison AAF	38-43	77-11	21
	NYG		3	Quantico MCAS	38-30	77-18	4
72401	RIC		4	Richmond WBAS	37-30	77-19	51
72411	ROA		5	Roanoke	37-19	79-59	358
	FAF		6	Fort Eustis/Felker AAF	37-08	76-37	4
74598	LFI		7	Hampton/Langley AFB	37-05	76-21	3
	NGU		8	Norfolk FWC	36-56	76-17	5
	NTU		9	Oceana NWSED	36-49	76-02	6
		Washington					
72798	TTI		1	Tatoosh Island WBO	48-23	124-44	26
	NUW		2	Whidbey Island NWSED	48-21	122-39	14
	PAE		3	Everett/Paine Fld.	47-55	122-17	184
	NEJ		4	Seattle FWC	47-41	122-16	15
	SKA		5	Spokane/Fairchild AFB	47-38	117-39	750
72785	GEG		6	Spokane IAP WBAS	47-37	117-32	723
74206	TCM		7	Tacoma/McChord AFB	47-09	122-29	98
74207	GRF		8	Fort Lewis/Gray AAF	47-05	122-35	92
	LRN		9	Moses Lake/Larson AFB	47-11	119-20	361
	ALW		10	Walla Walla FAA	46-06	118-17	367
		West Virginia					
72417	EKN		1	Elkins	38-53	79-51	605

Table 2. Station Locator (Cont)

WMO Number (Call Letters)	State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
	Wisconsin					
72645 GRB		1	Green Bay	44-29	88-08	214
VOK		2	Camp Douglas/Volk Fld.	43-56	90-16	279
72641 MSN		3	Madison/Truax Fld.	43-08	89-20	262
72640 MKE		4	Milwaukee/Mitchell Fld.	42-57	87-54	220
	Wyoming					
72665 SHR		1	Sheridan County Apt.	44-46	106-59	1226
72569 CPR		2	Casper	42-54	106-28	1629
72576 LND		3	Lander/Hunt Fld.	42-49	108-44	1703
72574 RKS		4	Rock Springs	41-36	109-04	2057
72564 CYS		5	Cheyenne WBAS	41-09	104-48	1876
	Canada					
72892 YQQ		1	Comox BC	49-43	124-53	24
72896 YXS		2	Prince George BC	53-53	122-41	692
74104 YWL		3	Williams Lake BC	52-11	122-03	940
74108 YXX		4	Abbotsford BC	49-01	122-22	58
72877 YYC		5	Calgary Alberta	51-06	114-01	1084
74121 YED		6	Edmonton Alberta/Namao	54-41	113-28	688
72932 YMM		7	Fort McMurray Alberta	56-39	111-13	369
74120 YOD		8	Cold Lake Alberta	54-22	110-17	544
72866 YXE		9	Saskatoon Saskatchewan	52-10	106-42	504
72864 YMJ		10	Moose Jaw Saskatchewan	50-20	105-34	577
72867 YQD		11	The Pas Manitoba	53-58	101-06	271
72851 YPG		12	Portage La Prarie Manitoba	49-54	98-16	270
72856 YGM		13	Gimli Manitoba	50-38	97-03	230
72852 YWG		14	Winnipeg Manitoba	49-55	97-14	238
72913 YYQ		15	Churchill Manitoba	58-44	94-04	29
72749		16	Fort William Ontario/Lakehead	48-22	89-19	211
72725 YVO		17	Val D'Or Quebec	48-03	77-47	338
72731 YYB		18	North Bay Ontario	46-22	79-25	371
72624 YYZ		19	Toronto Ontario/Malton	43-41	79-38	173
YHU		20	St. Hubert Quebec	45-31	73-25	27
72727 YBG		21	Bagotville Quebec	48-20	71-00	159
72816 YYR		22	Goose Bay Newfoundland	53-19	60-26	47
72717 YCH		23	Chatham NB	47-00	65-27	34
74397 YZX		24	Greenwood Nova Scotia	44-59	64-55	25

Table 2. Station Locator (Cont)

WMO Number (Call Letters)	State	Map Number	Station Name	Lat. (°N)	Long. (°W)	Altitude (m)
72601 YAW	Canada (Cont)	25	Shearwater Nova Scotia	44-38	63-30	50
72707 YQY		26	Sydney Nova Scotia	46-10	60-03	62
72600 YSA		27	Sable Island Nova Scotia	43-56	60-01	2
72807		28	Argentia FWF Newfoundland	47-12	54-01	14
	Caribbean Islands					
78063		1	Gold Rock Creek/Grand Bahama AAFB	26-37	78-20	7
78077		2	Eleuthera Island AAFB	25-16	76-18	26
78118 MKJT		3	Grand Turk Island AAFB	21-26	71-08	3
78267 MUGT		4	Guantanamo Bay Cuba NWSED	20-04	75-09	10

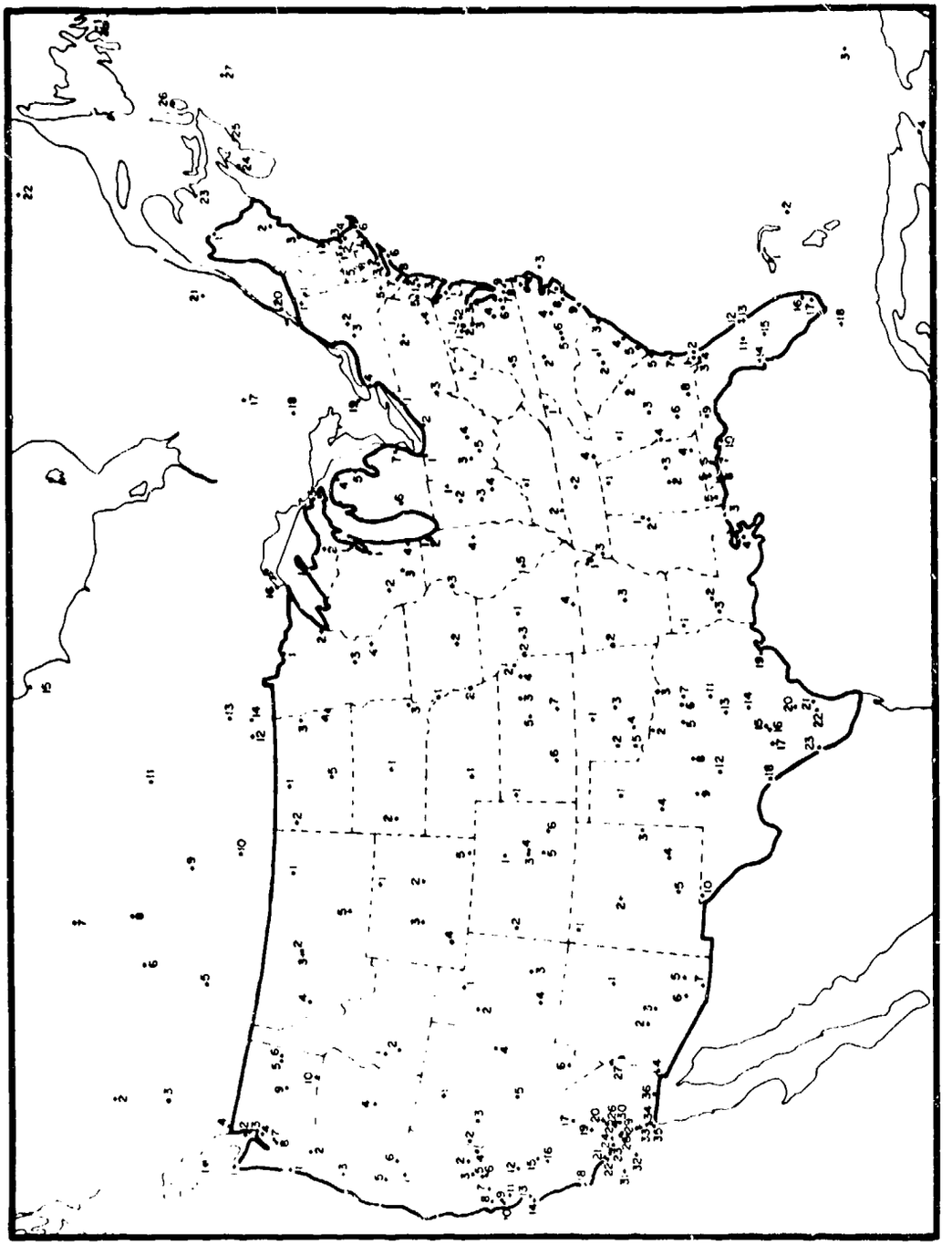

Figure 1. Station Locator Map

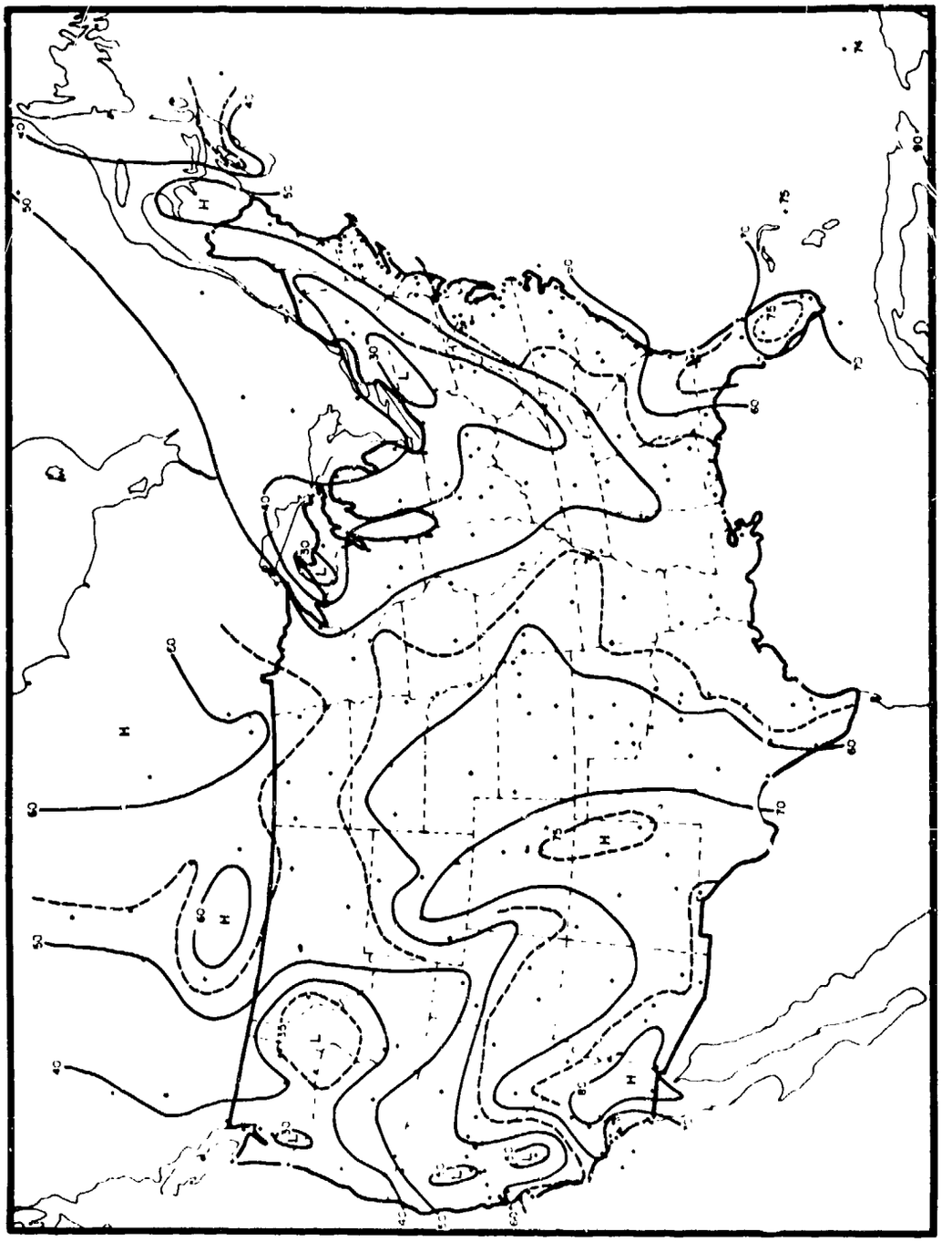

Figure 2. CFLOS Probabilities for Jan, 0000-0200 LST, 90° Elevation

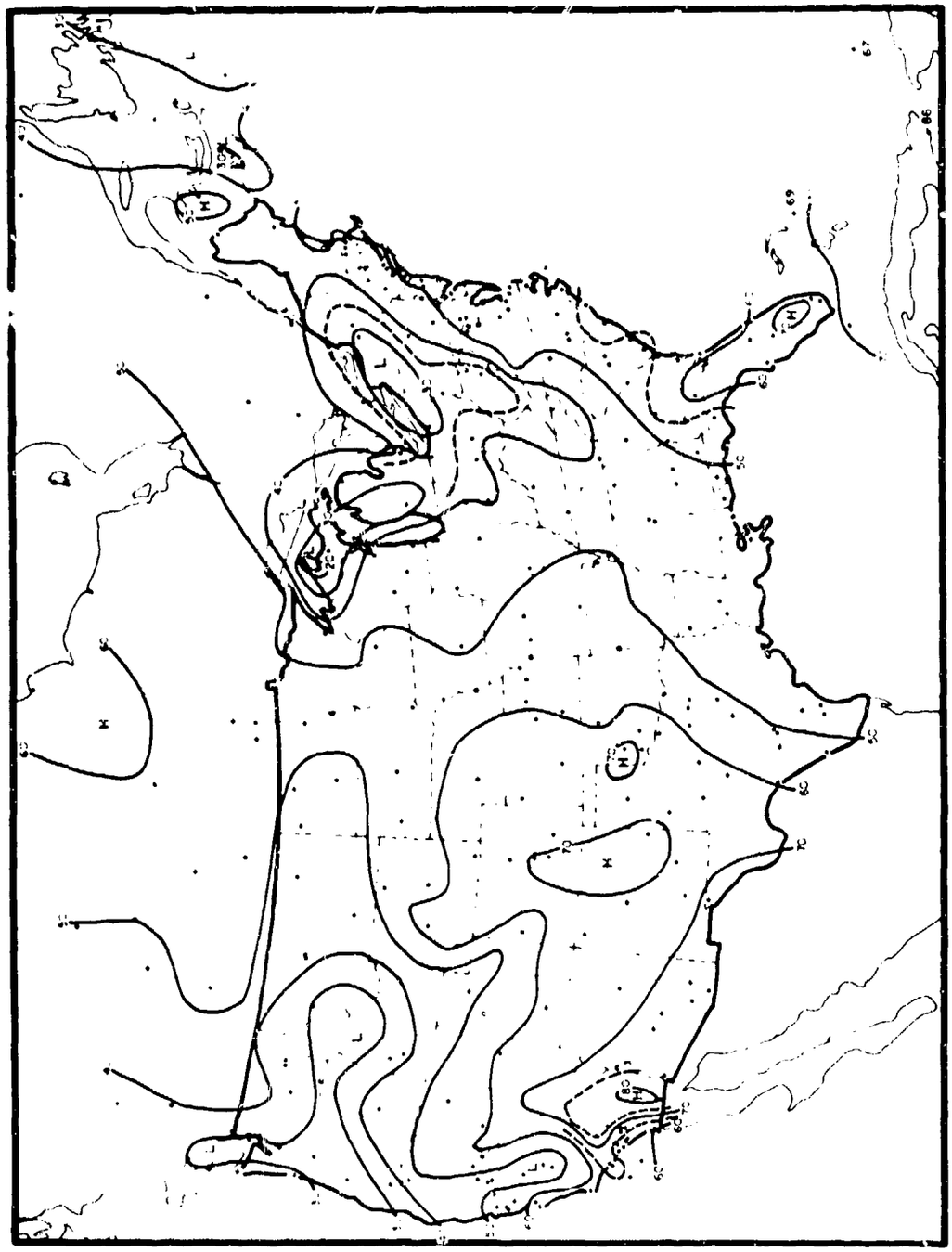

Figure 3. CFLOS Probabilities for Jan, 0000–0200 LST, 30° Elevation

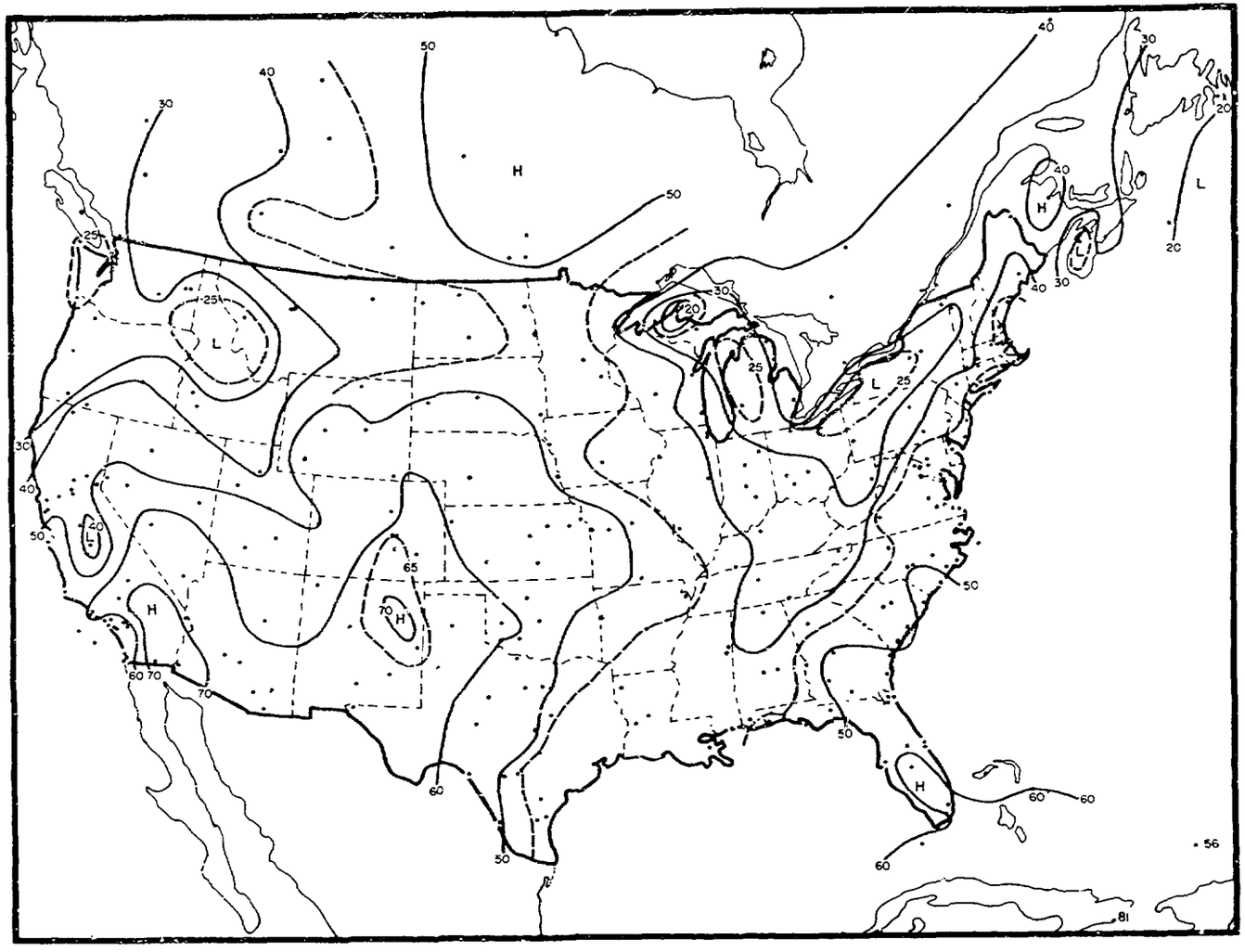

Figure 4. CFLOS Probabilities for Jan, 0000–0200 LST, 10° Elevation

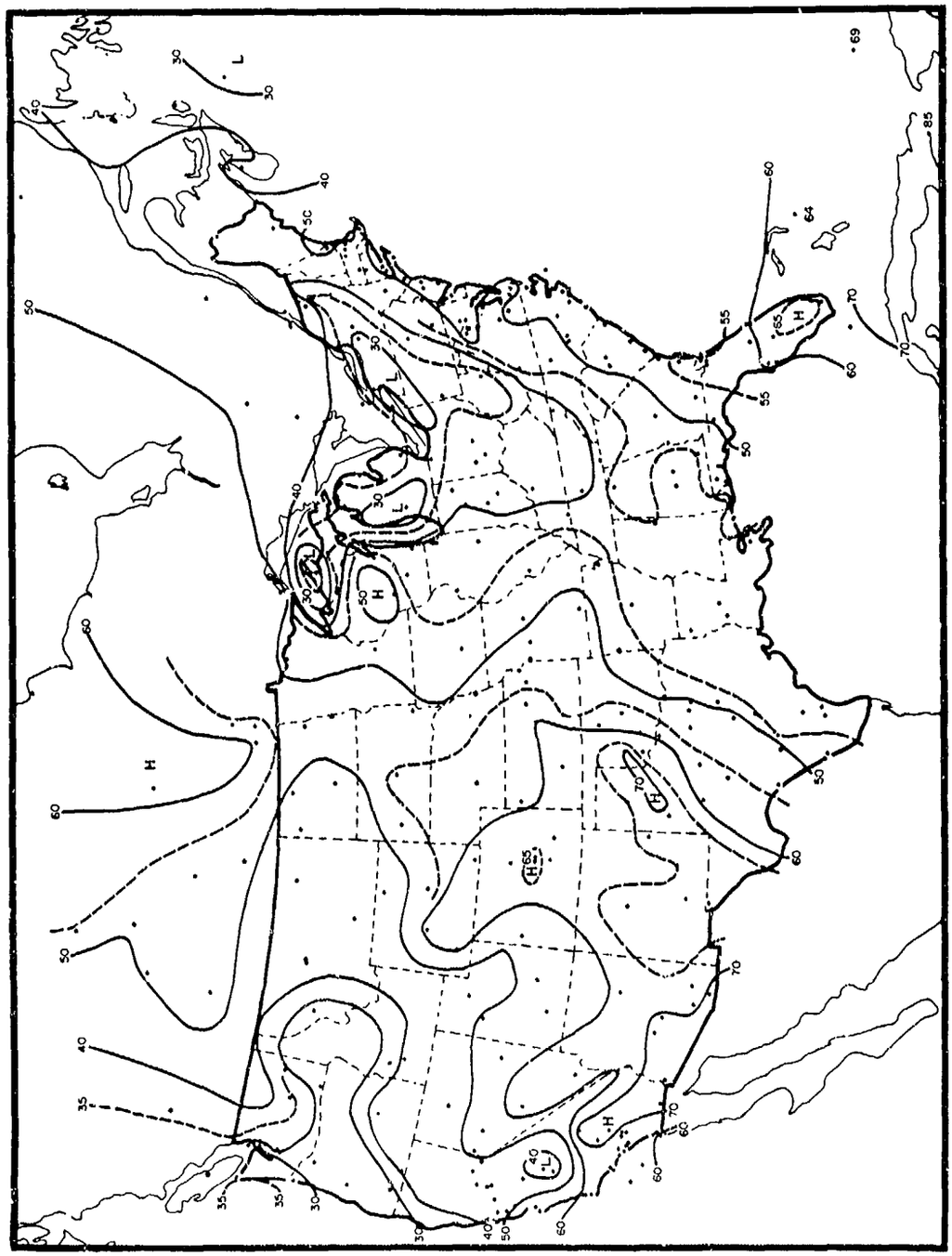

Figure 5. CFLOS Probabilities for Jan, 0600–0800 LST, 90° Elevation

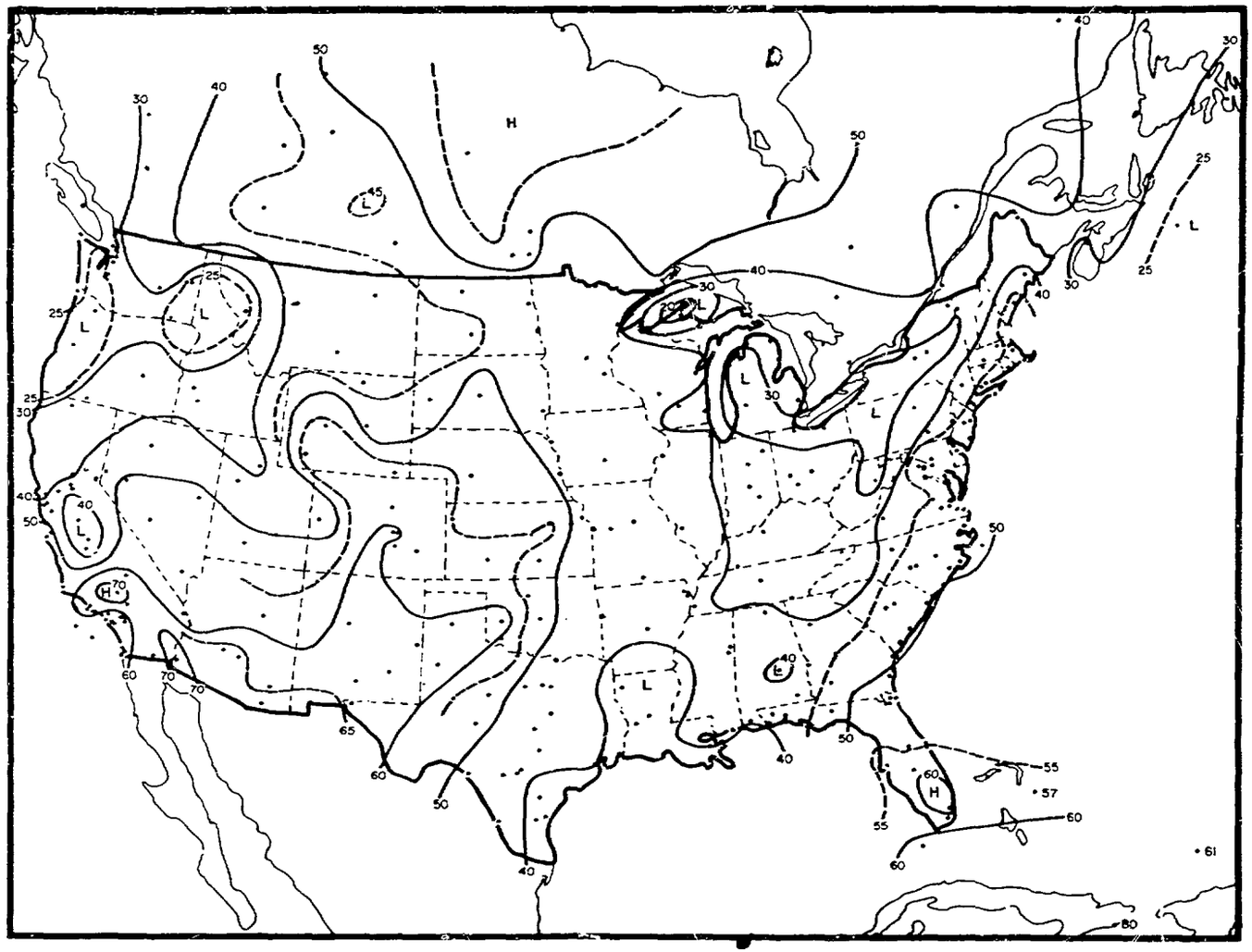

Figure 6. CFLOS Probabilities for Jan, 0600–0800 LST, 30° Elevation

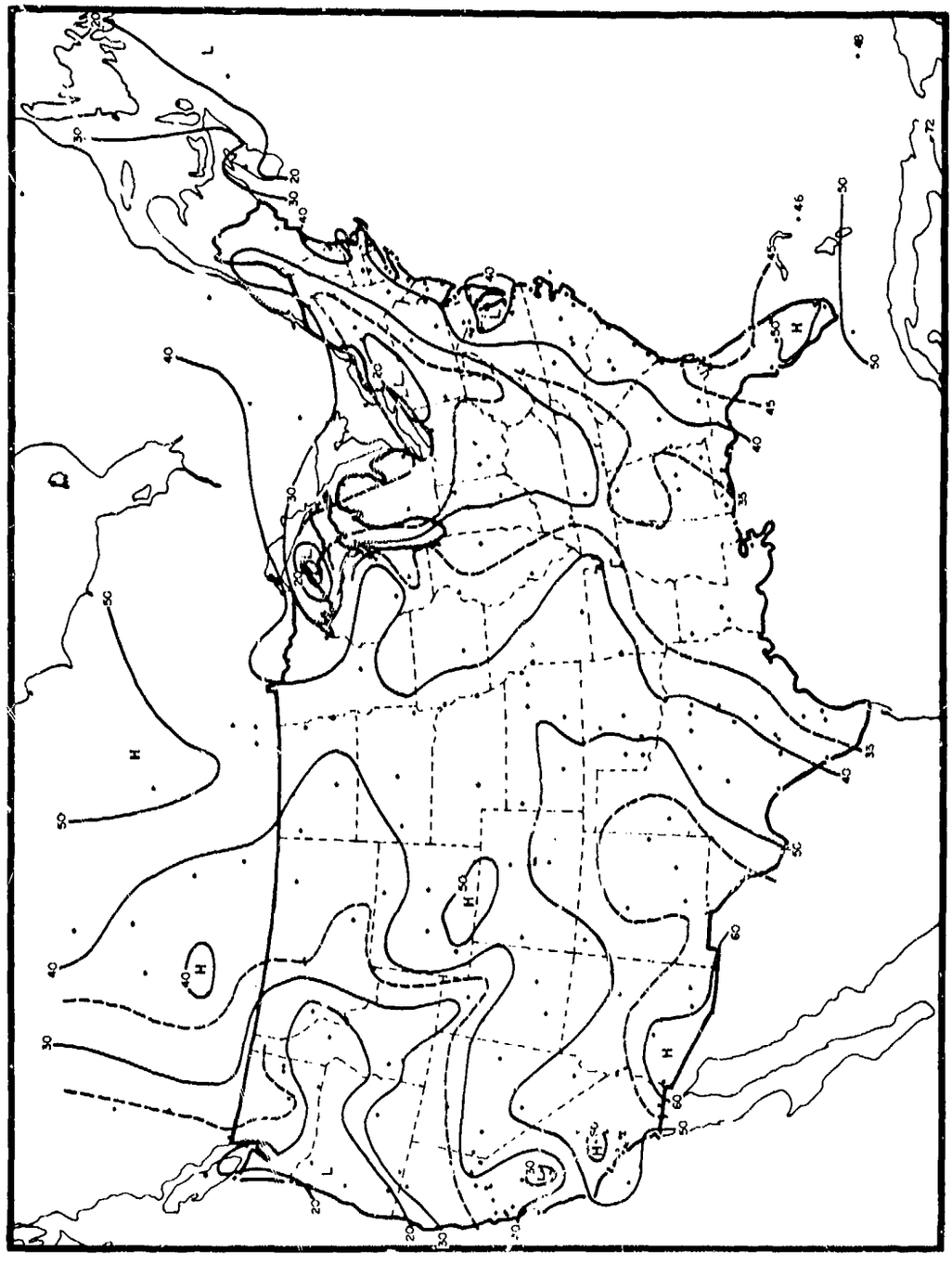

Figure 7. CFLOS Probabilities for Jan, 0600-0800 LST, 10° Elevation

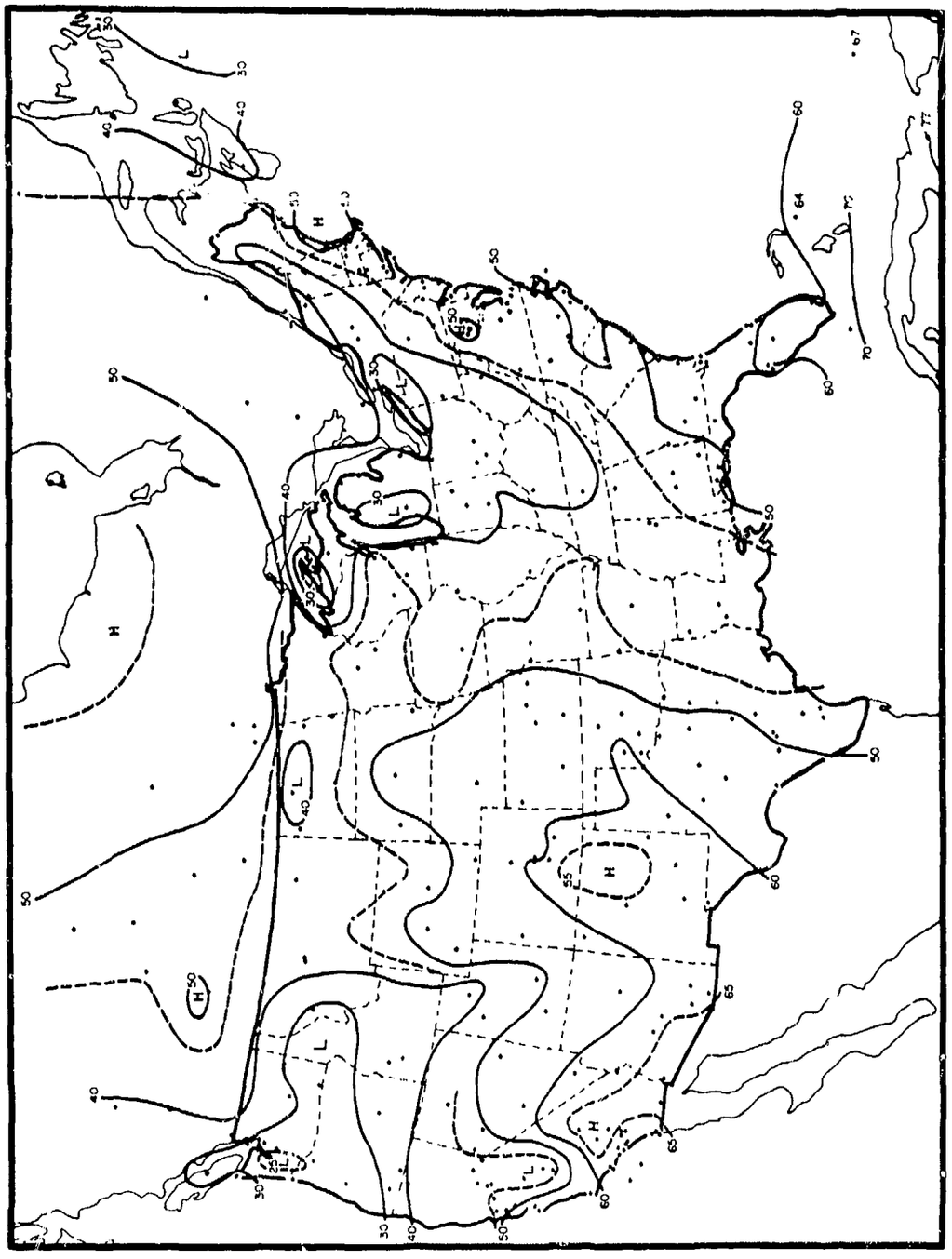

Figure 8. CFLOS Probabilities for Jan, 1200–1400 LST, 90° Elevation

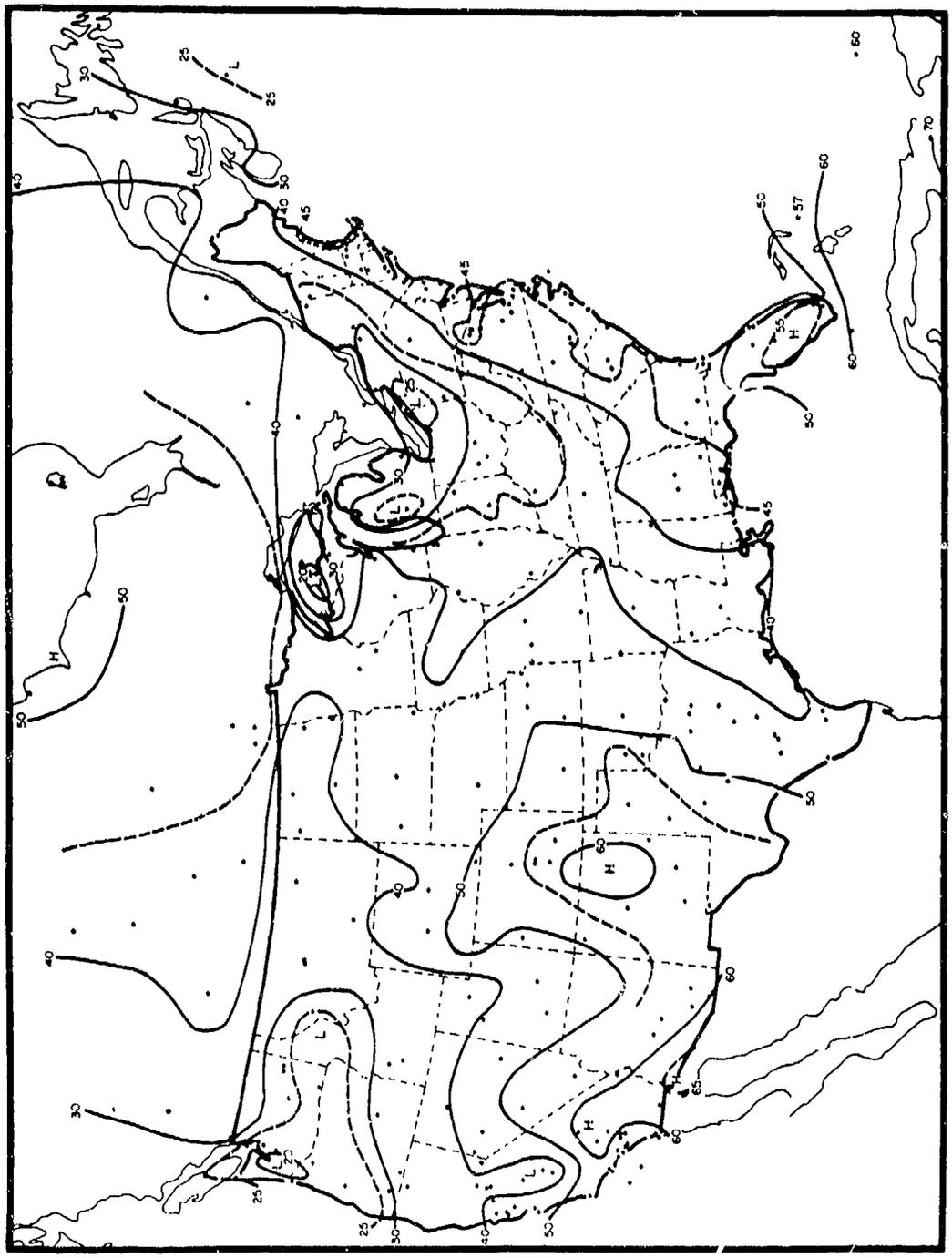

Figure 9. CFLOS Probabilities for Jan, 1200–1400 LST, 30° Elevation

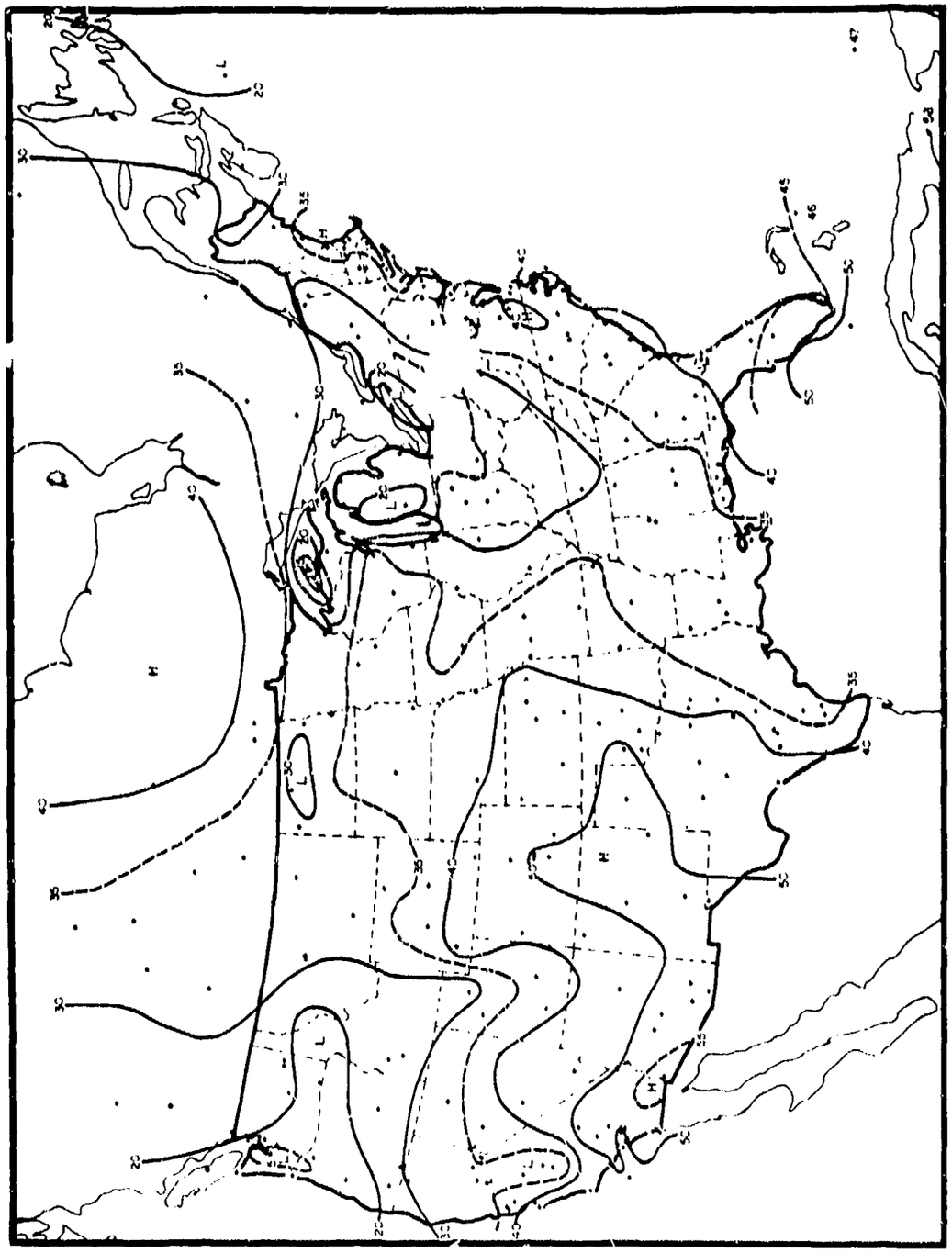

Figure 10. CFLOS Probabilities for Jan, 1200–1400 LST, 10° Elevation

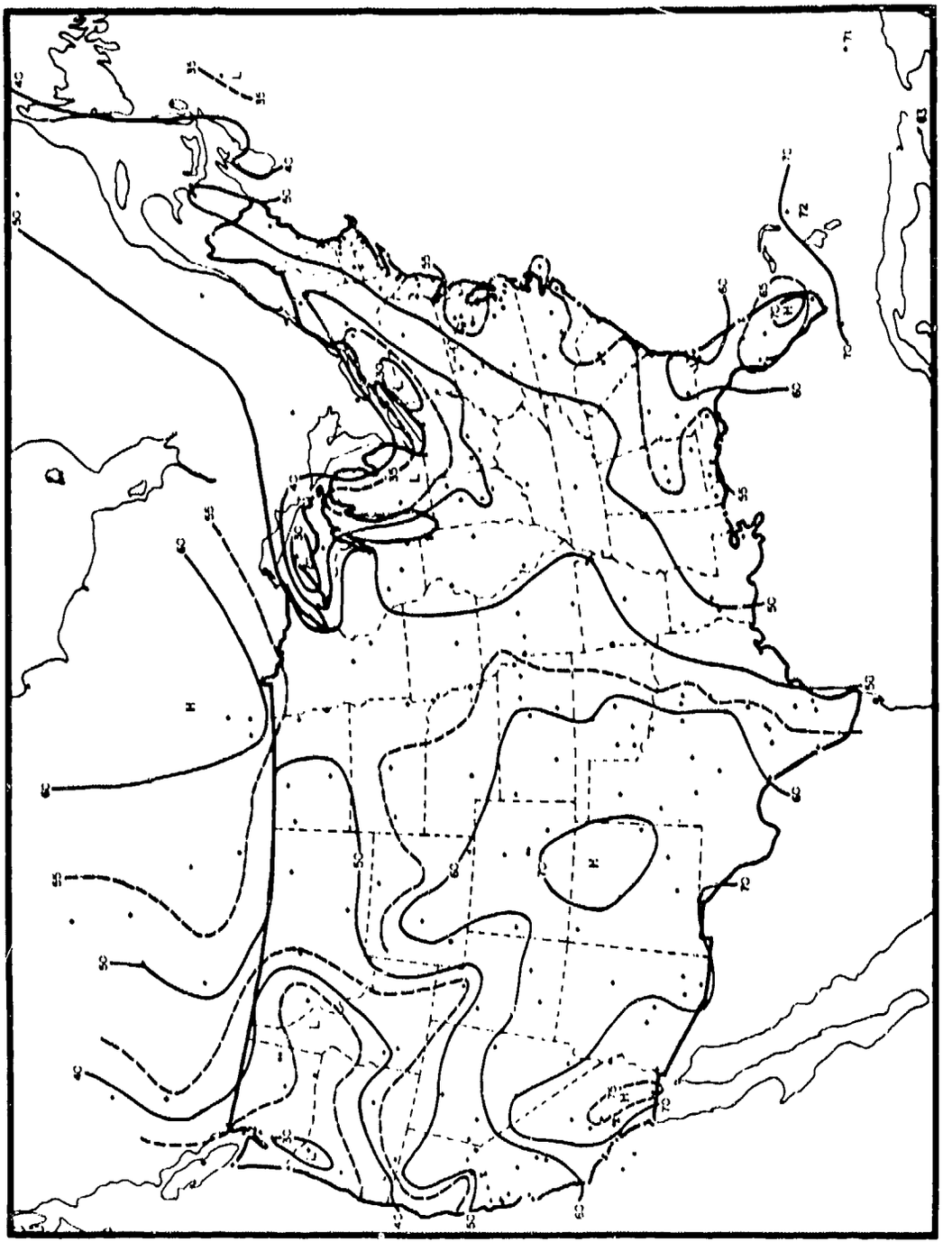

Figure 11. CFLOS Probabilities for Jan, 1800–2000 LST, 90° Elevation

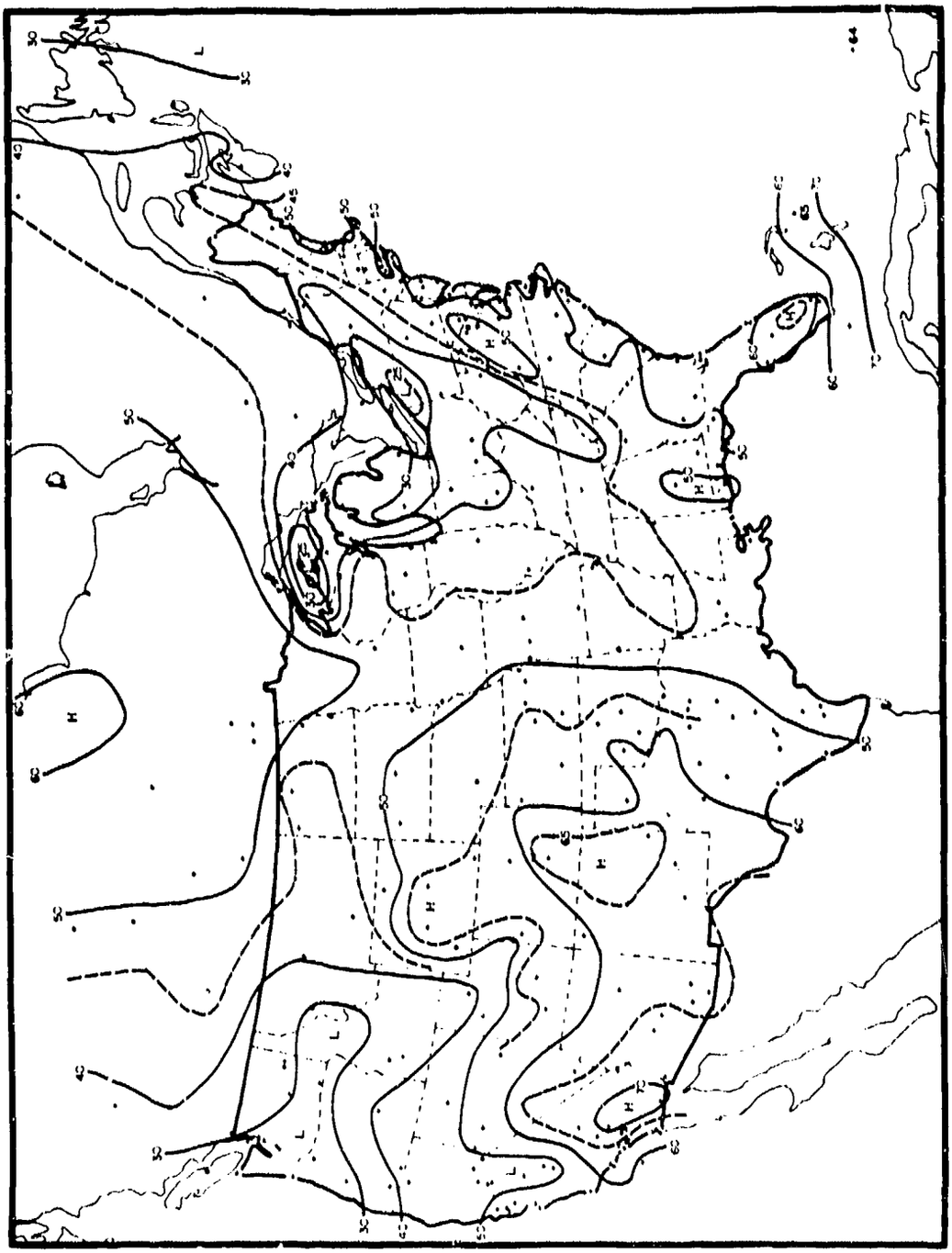

Figure 12. CFLOS Probabilities for Jan, 1800–2000 LST, 30° Elevation

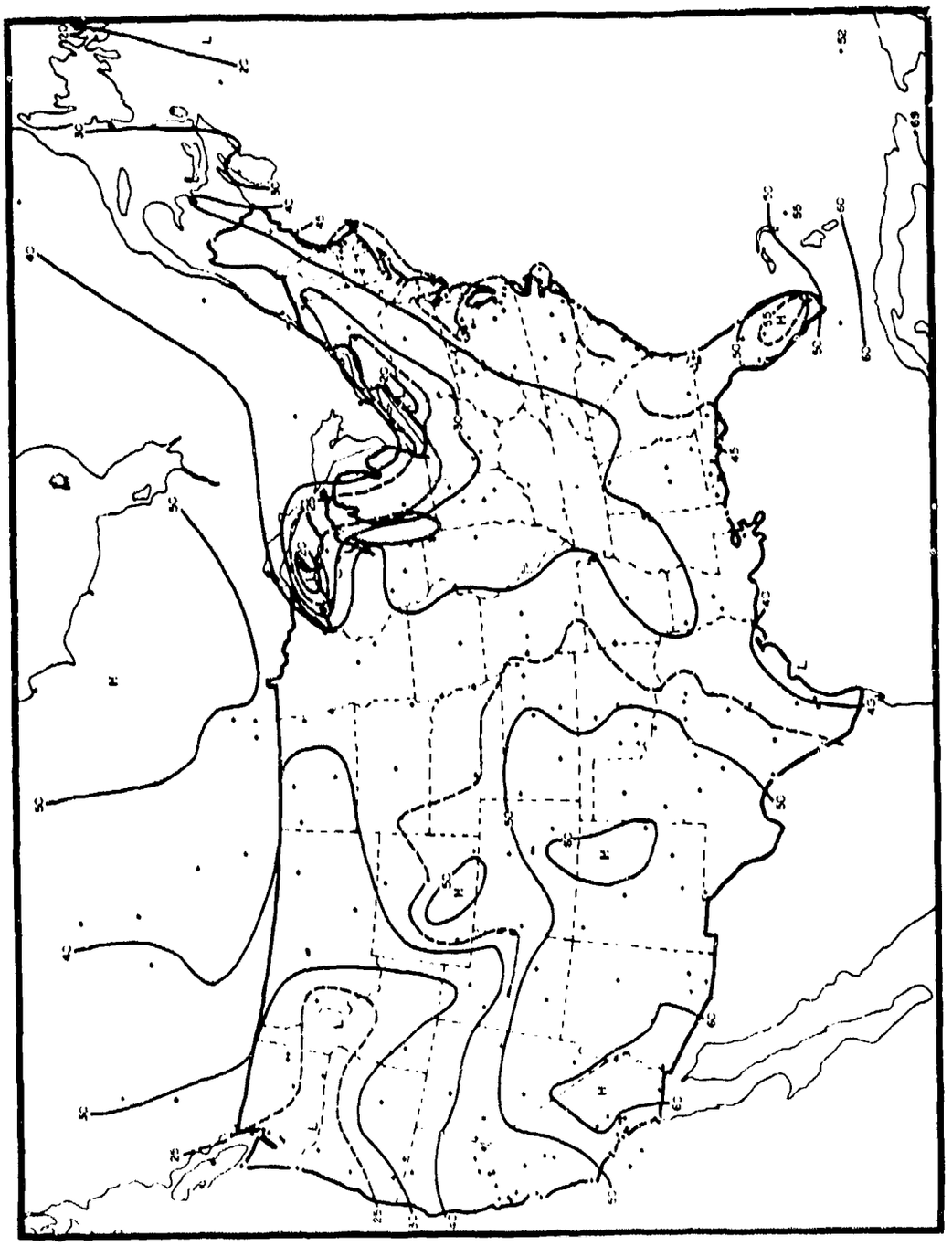

Figure 13. CFLOS Probabilities for Jan, 1800–2000 LST, 10° Elevation

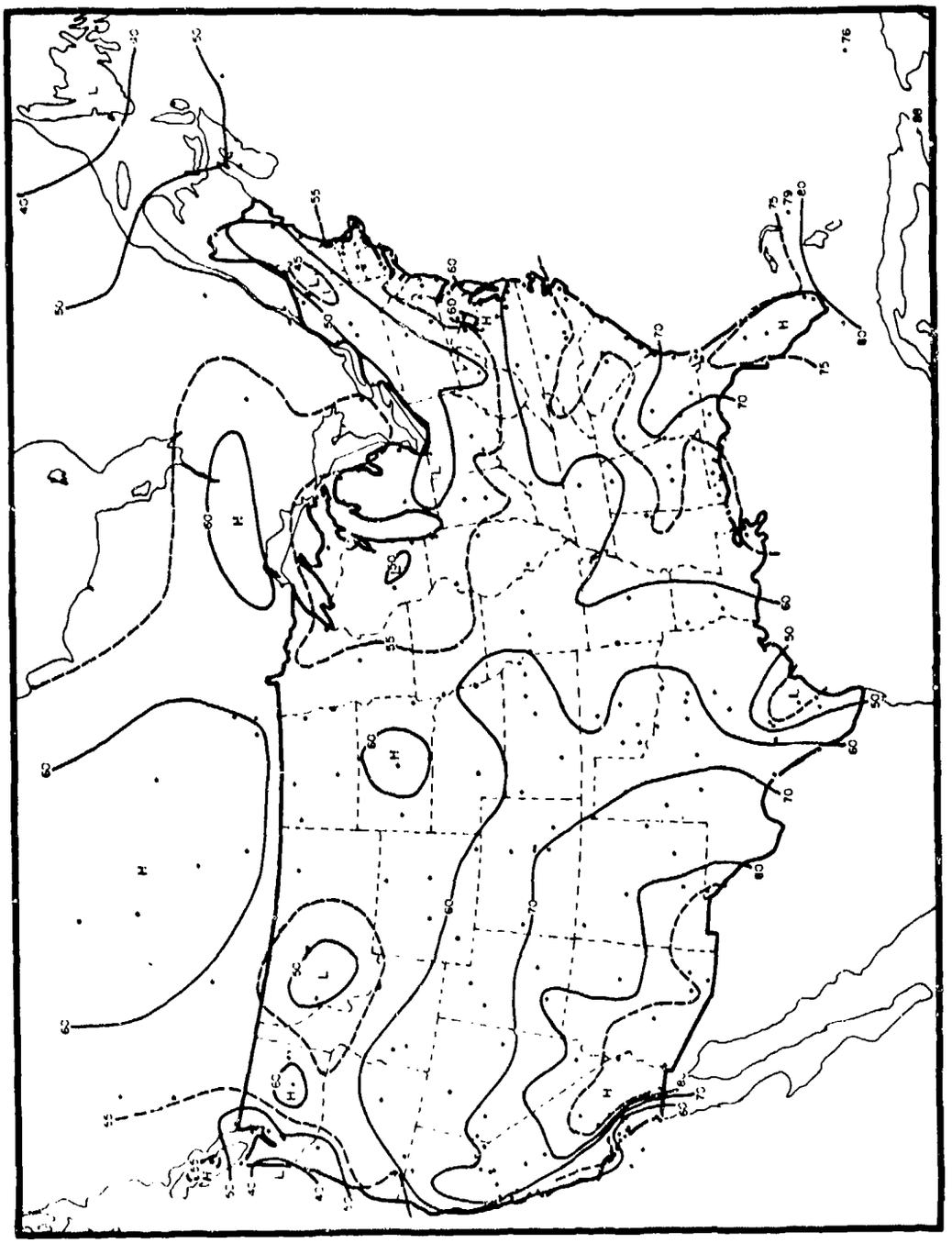

Figure 14. CFLOS Probabilities for Apr, 0000–0200 LST, 90° Elevation

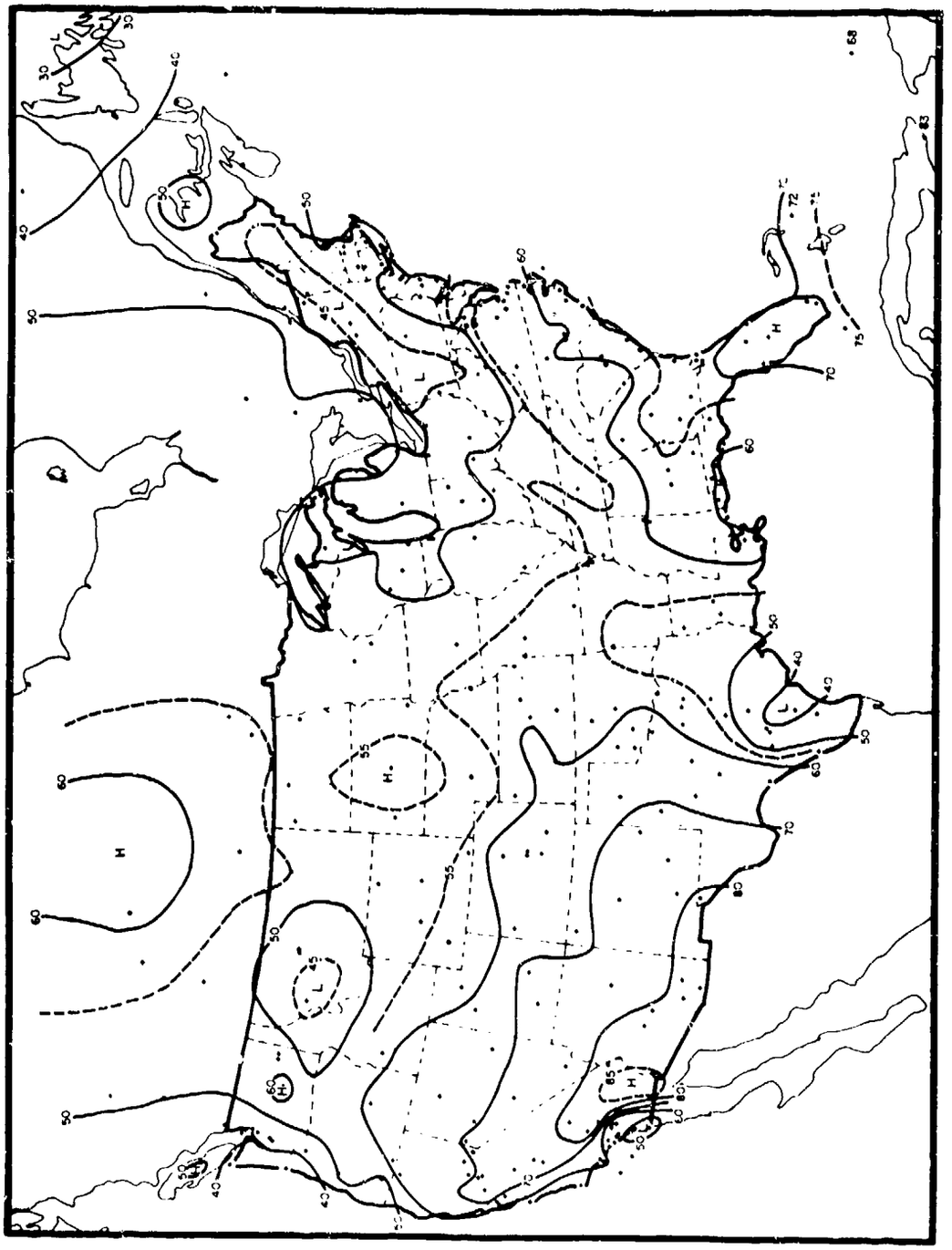

Figure 15. CFLOS Probabilities for Apr, 0000–0200 LST, 30° Elevation

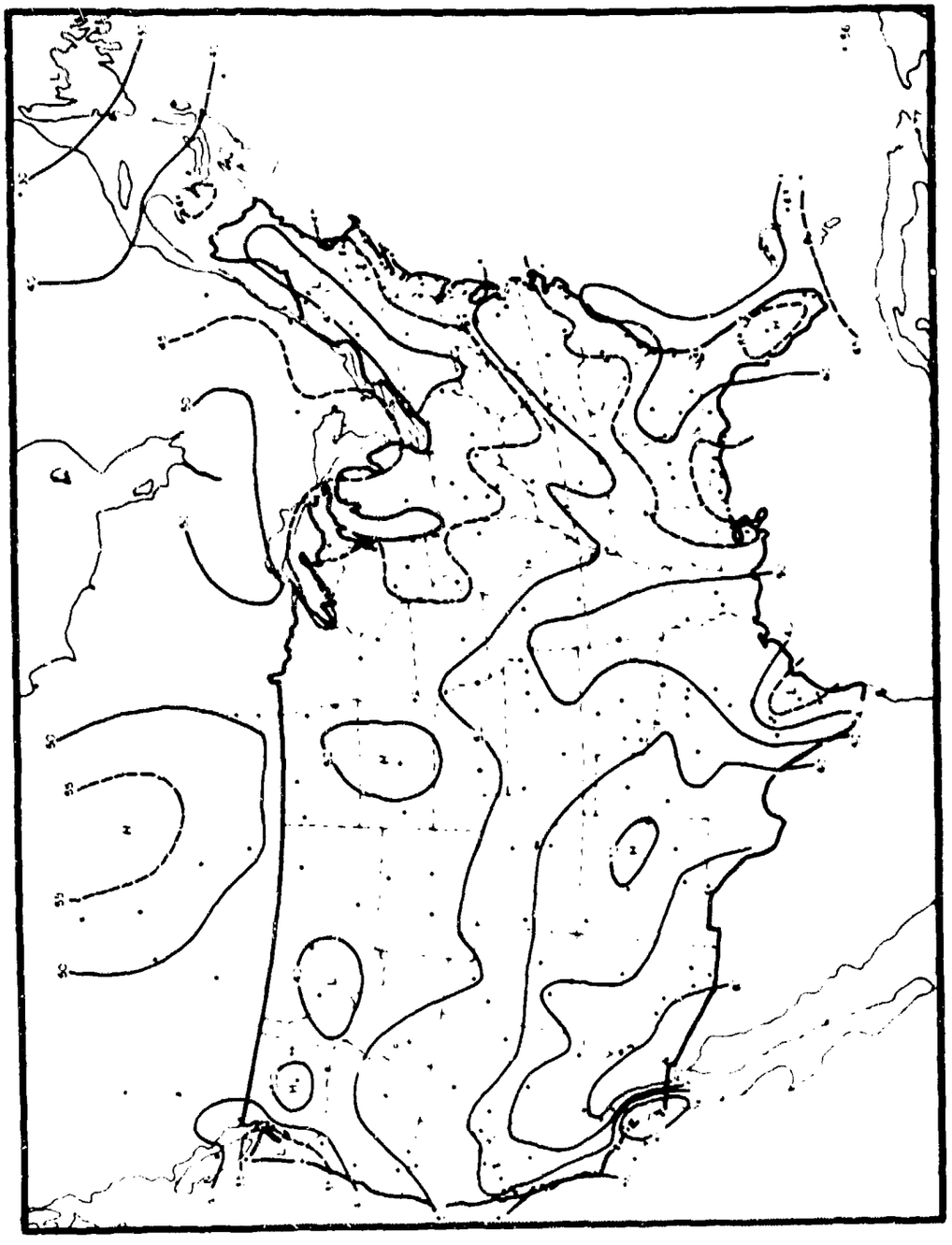

Figure 16. CFLOS Probabilities for Apr, 0000-0200 LST, 10° Elevation

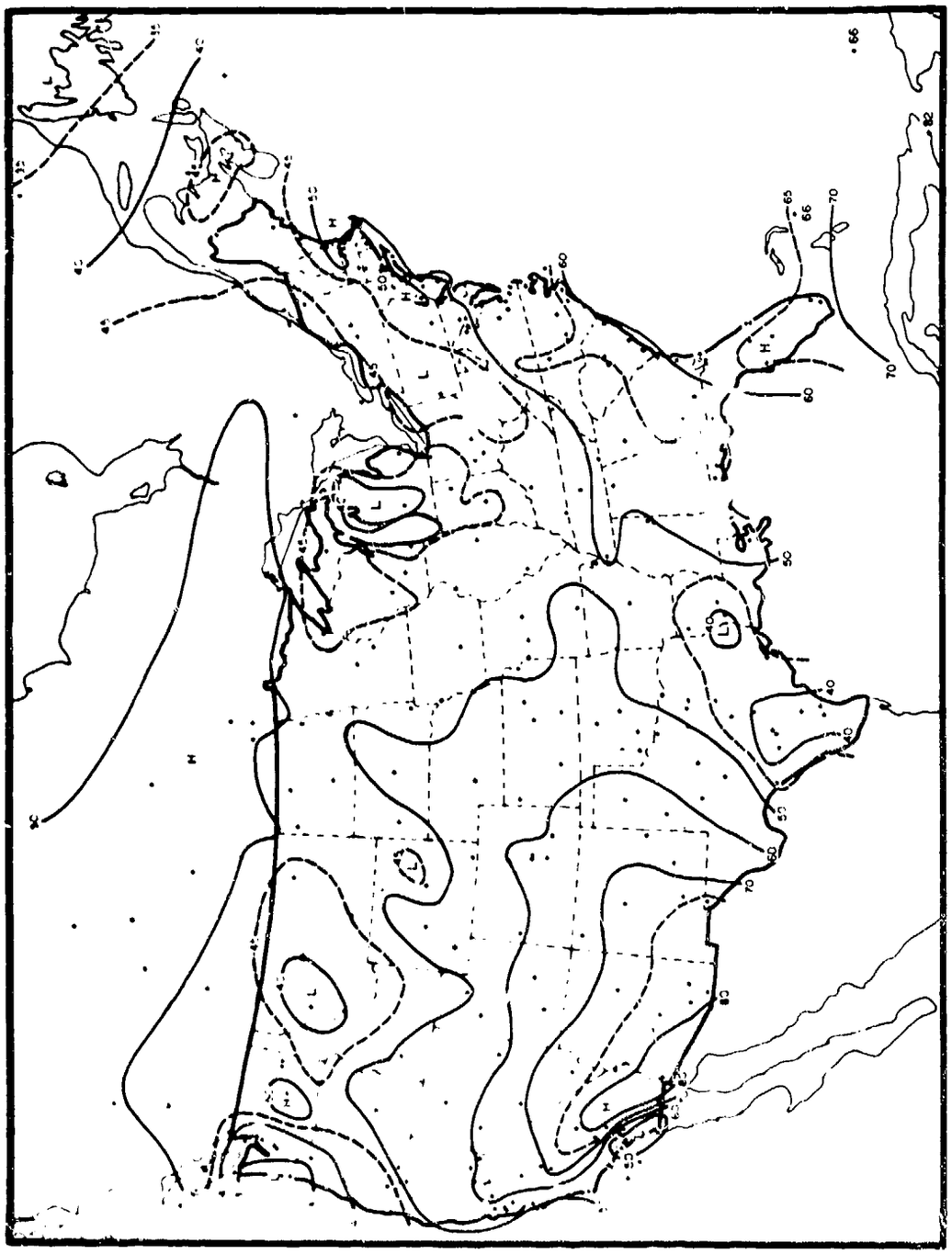

Figure 17. CFLOS Probabilities for Apr. 0600–0800 LST, 90° Elevation

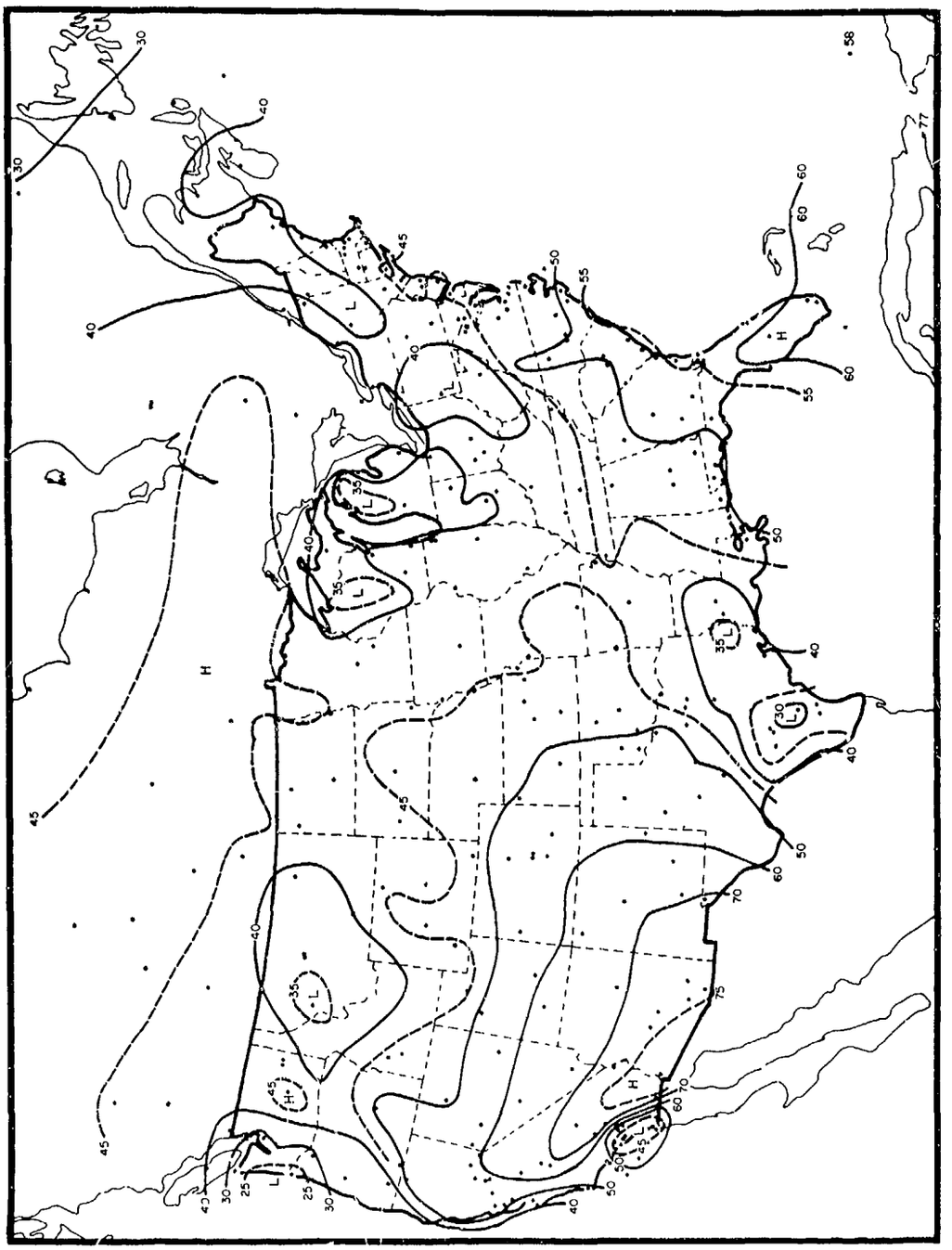

Figure 18. CFLOS Probabilities for Apr, 0600–0800 LST, 30° Elevation

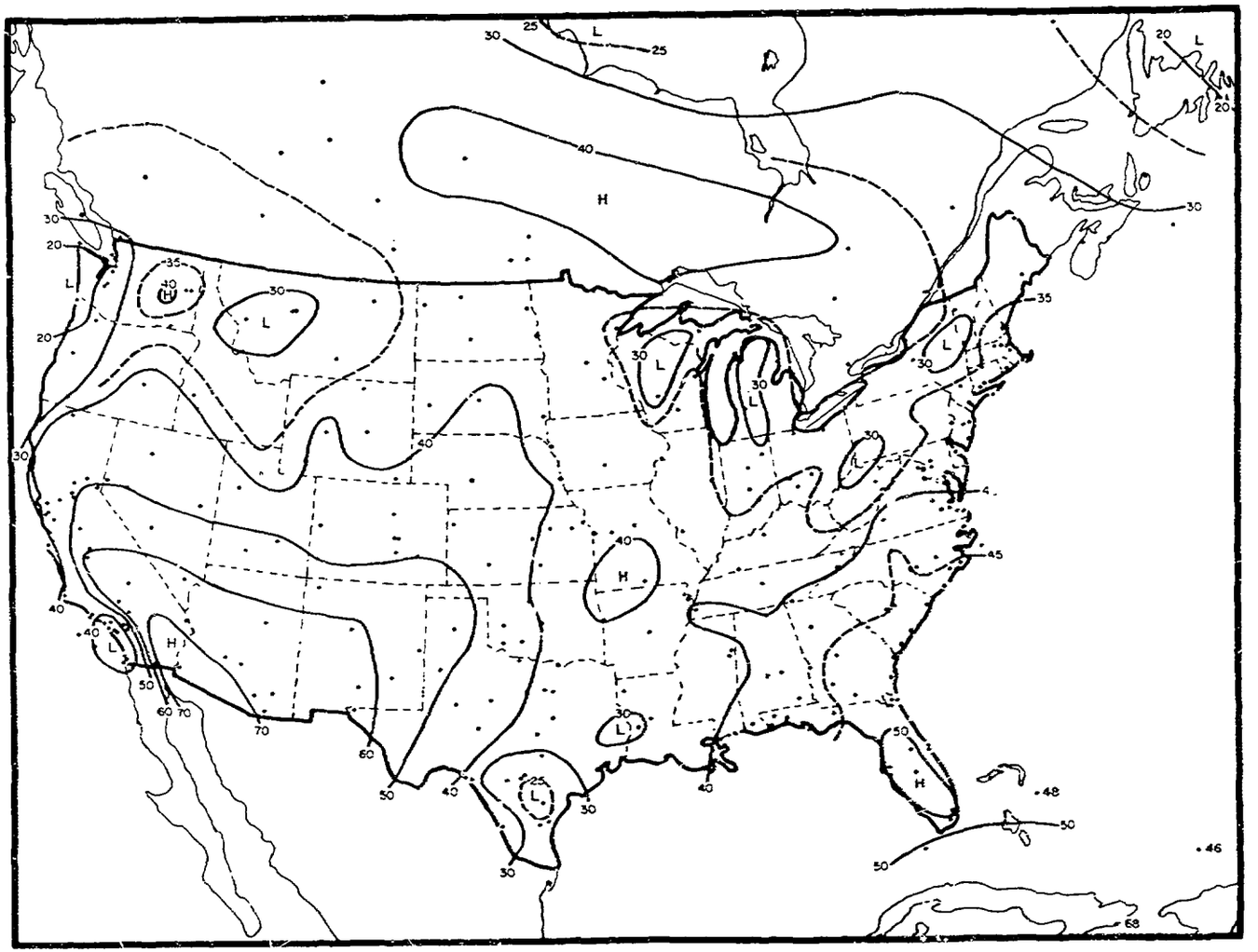

Figure 19. CFLOS Probabilities for Apr, 0600–0800 LST, 10° Elevation

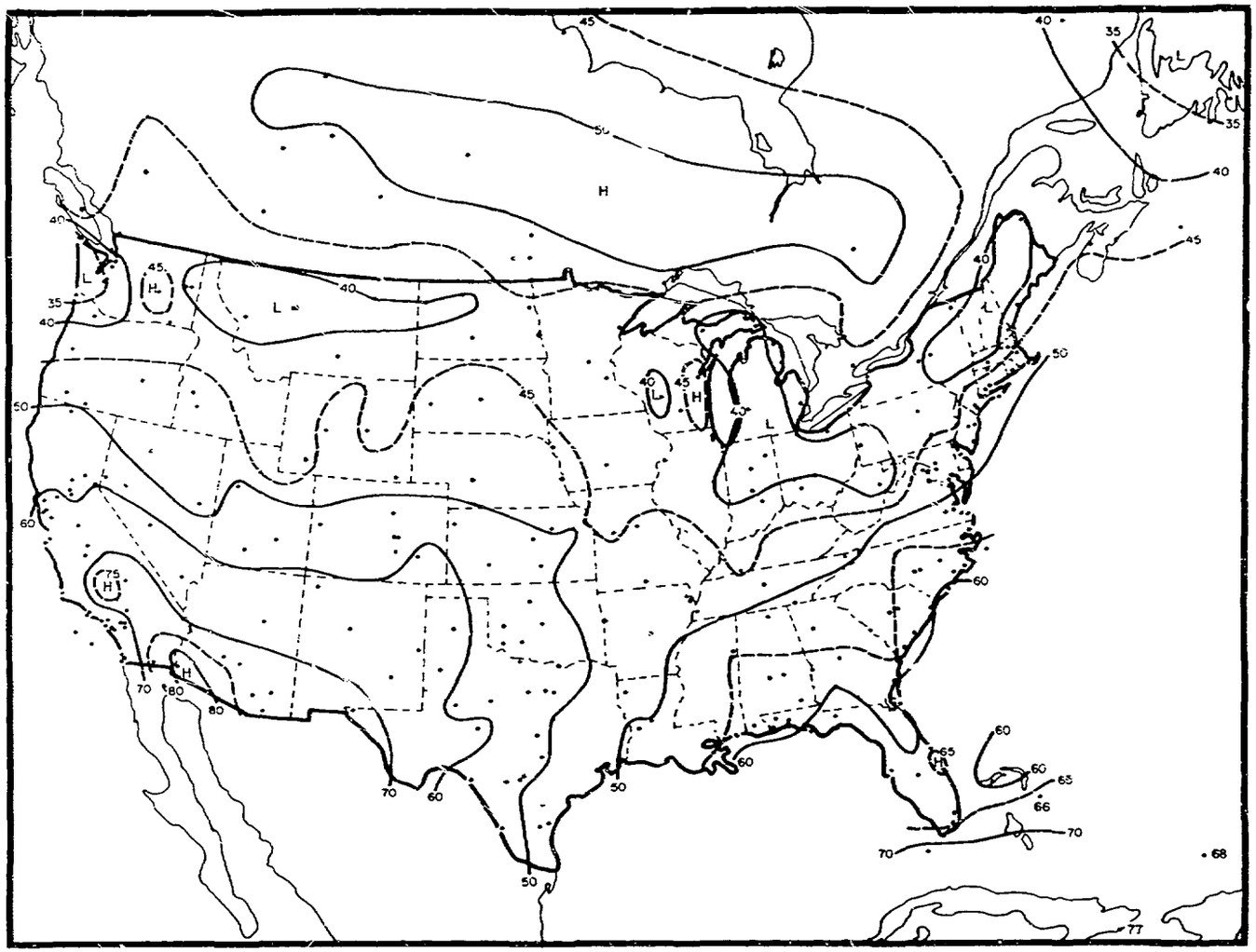

Figure 2C. CFLOS Probabilities for Apr, 1200–1400 LST, 90° Elevation

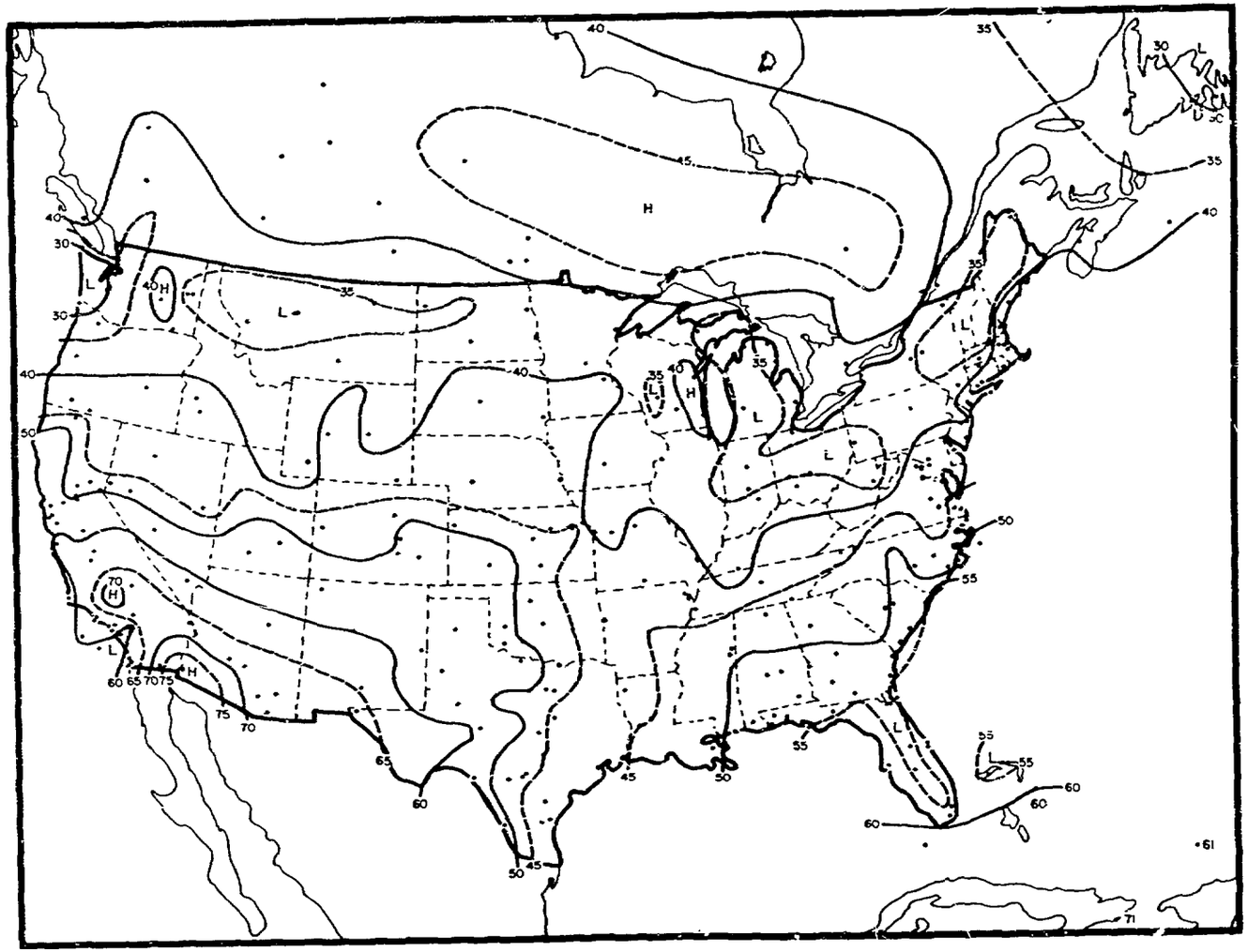

Figure 21. CFLOS Probabilities for Apr, 1200–1400 LST, 30° Elevation

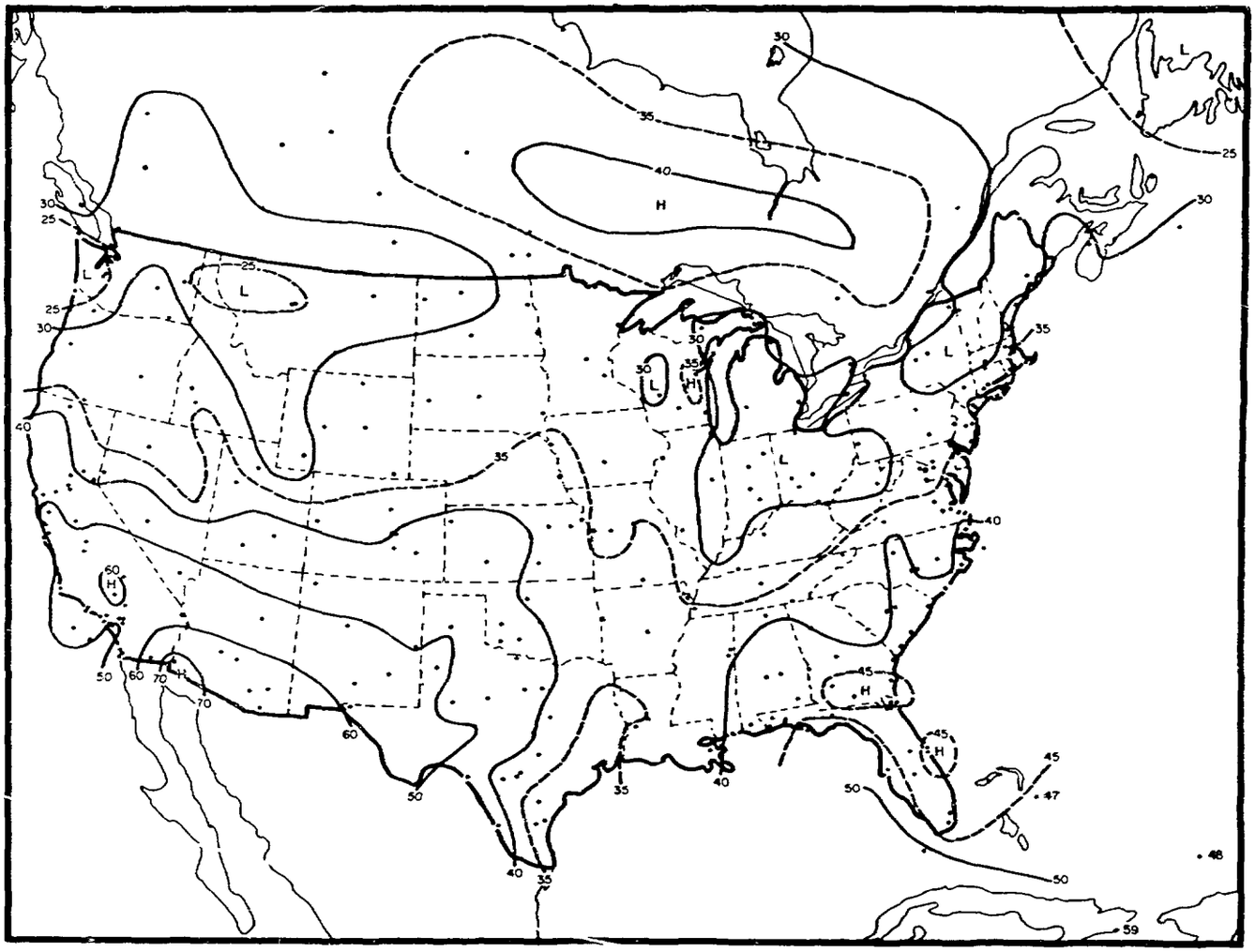

Figure 22. CFLOS Probabilities for Apr, 1200–1400 LST, 10° Elevation

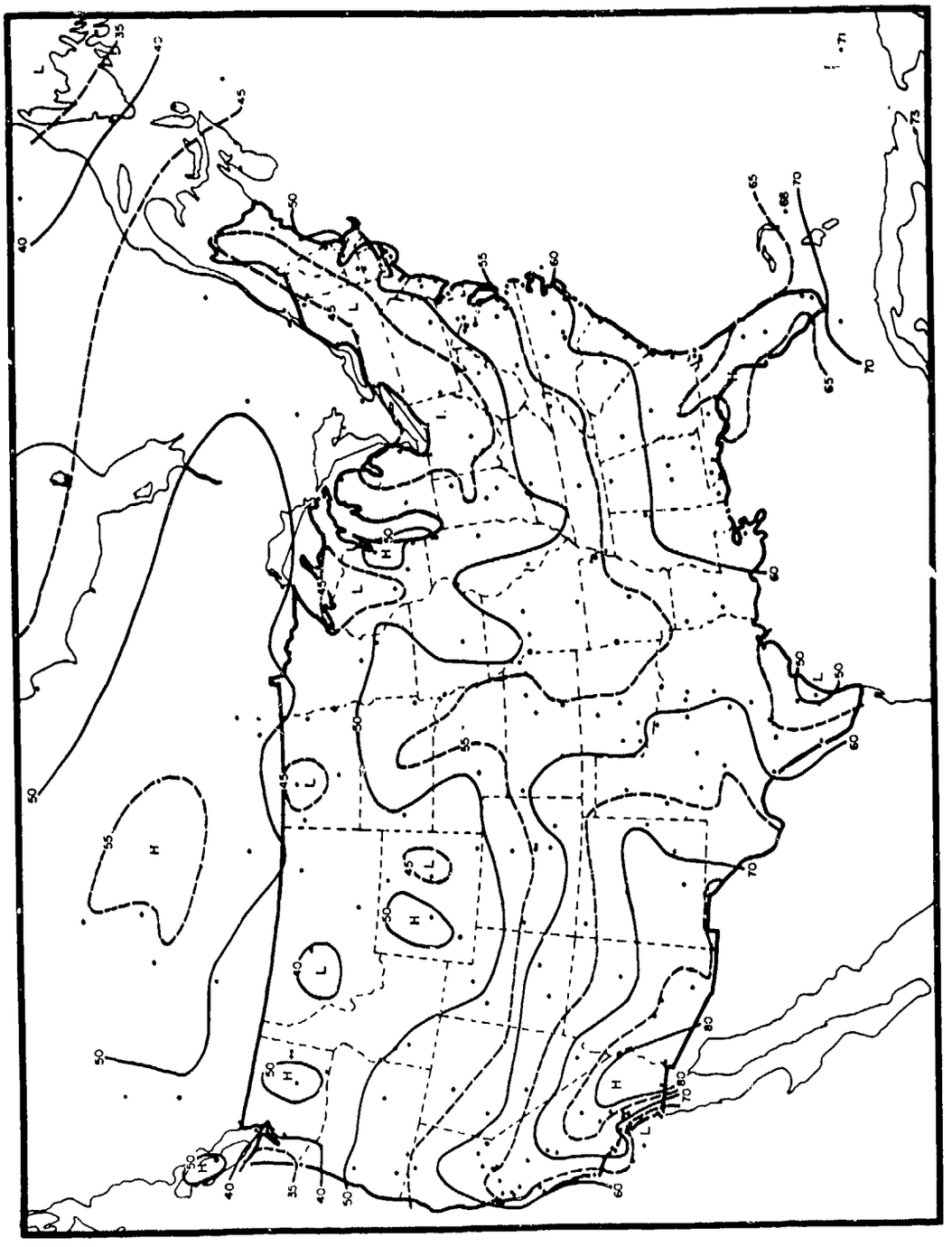

Figure 23. CFLOS Probabilities for Apr, 1800–2000 LST, 90° Elevation

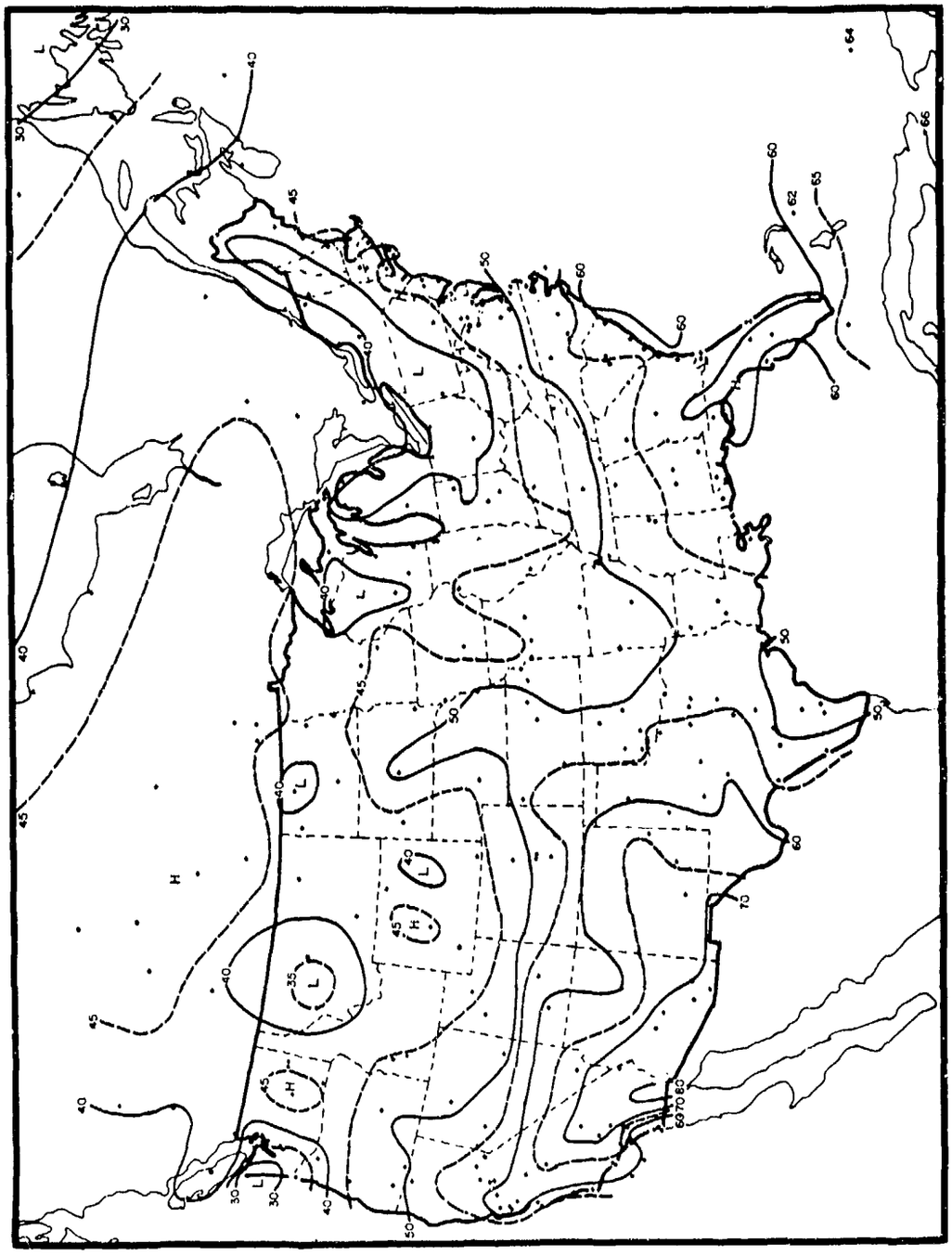

Figure 24. CFLOS Probabilities for Apr, 1800–2000 LST, 30° Elevation

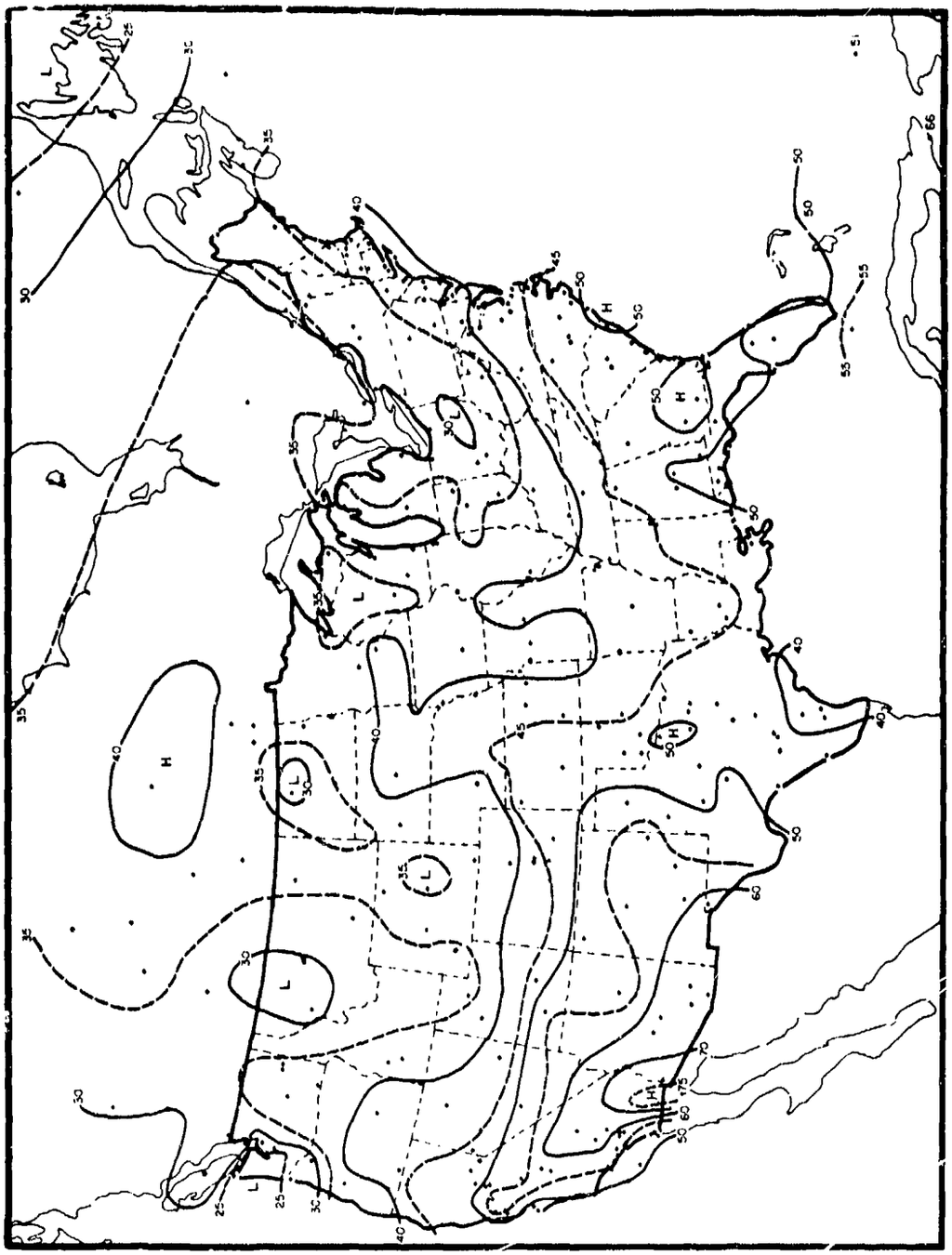

Figure 25. CFLOS Probabilities for Apr, 1800–2000 LST, 10° Elevation

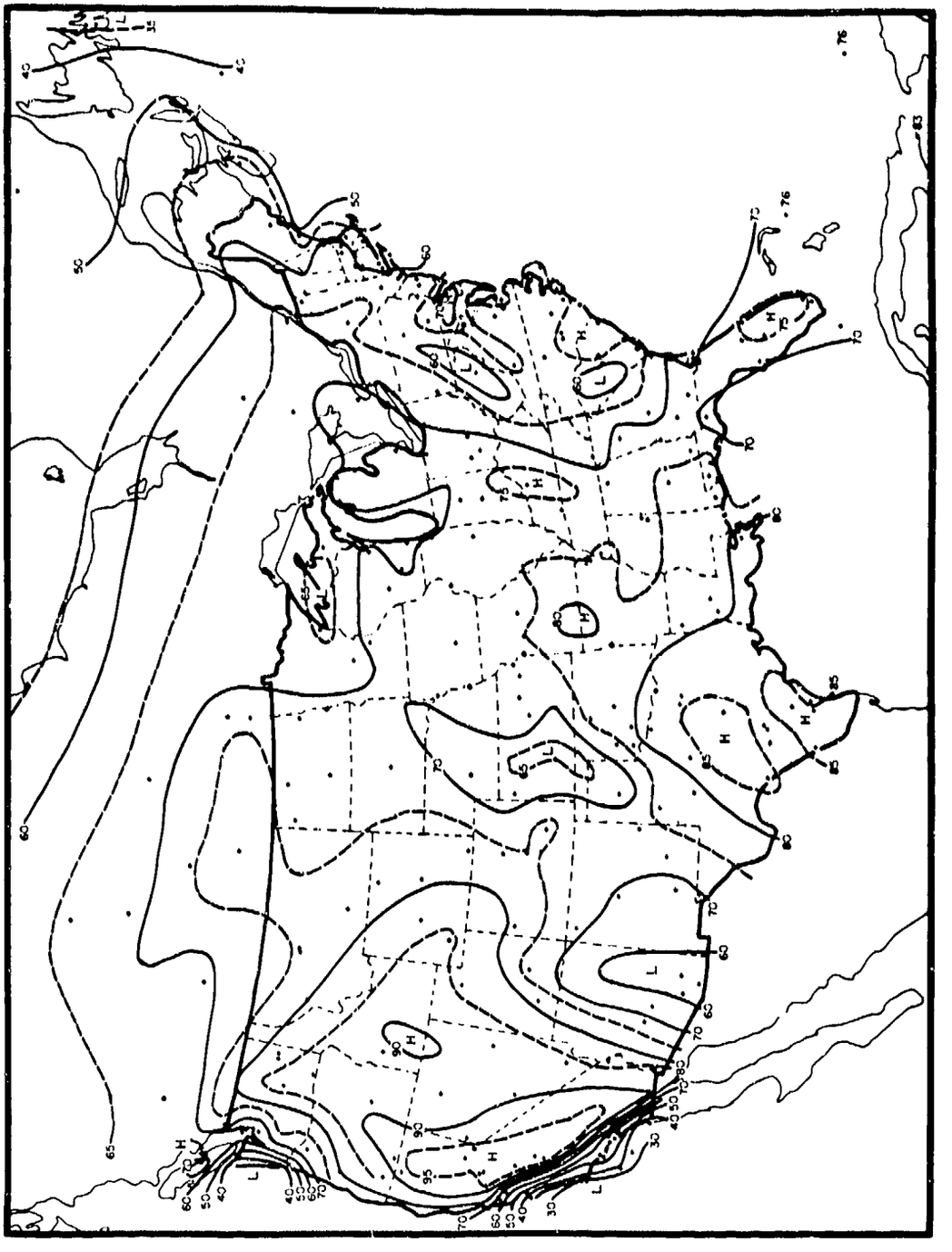

Figure 26. CFLOS Probabilities for July 0000–0200 LST, 90° Elevation

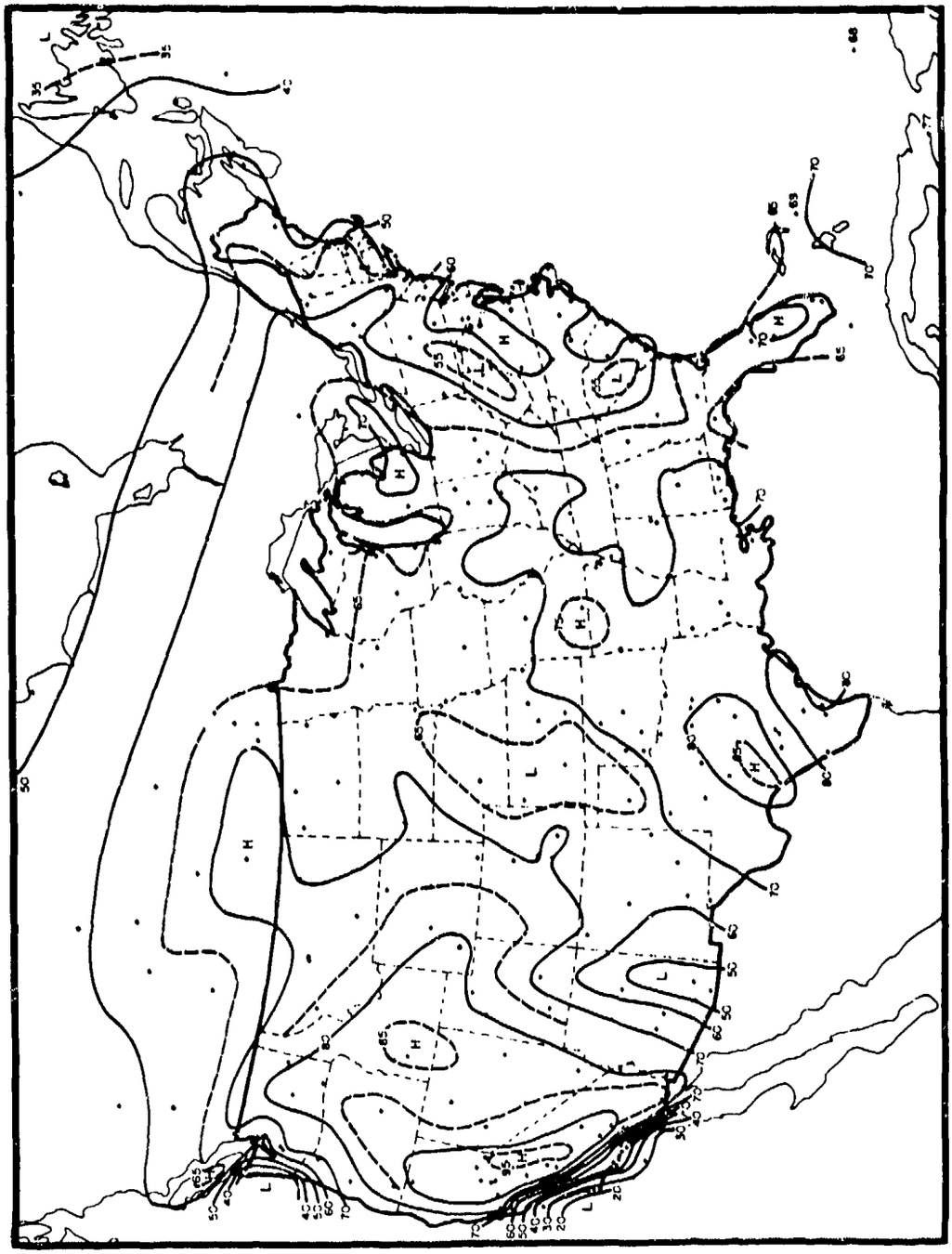

Figure 27. CFLOS Probabilities for July, 0000-0200 LST, 30° Elevation

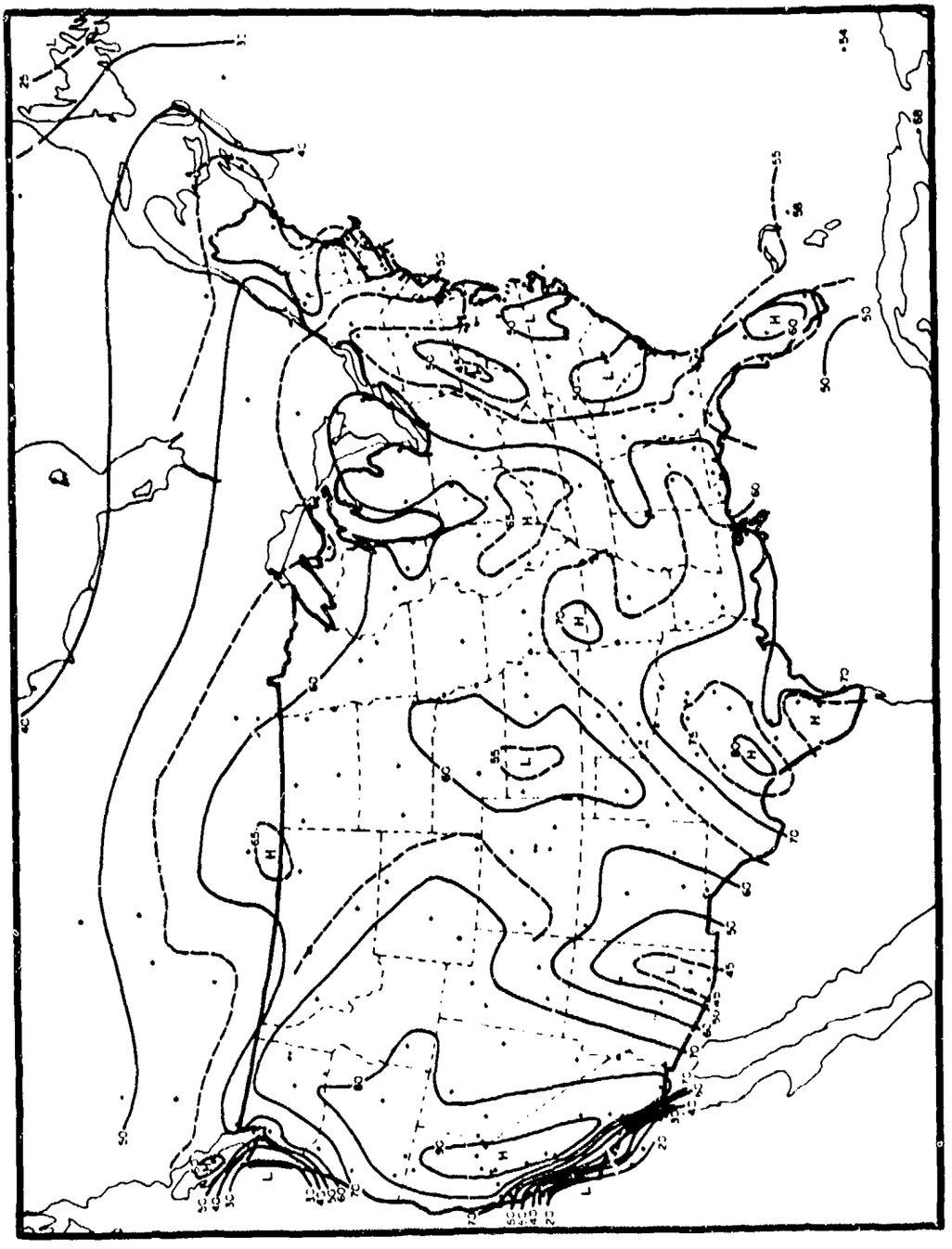

Figure 28. CFLOS Probabilities for July, 0000–0200 LST, 10° Elevation

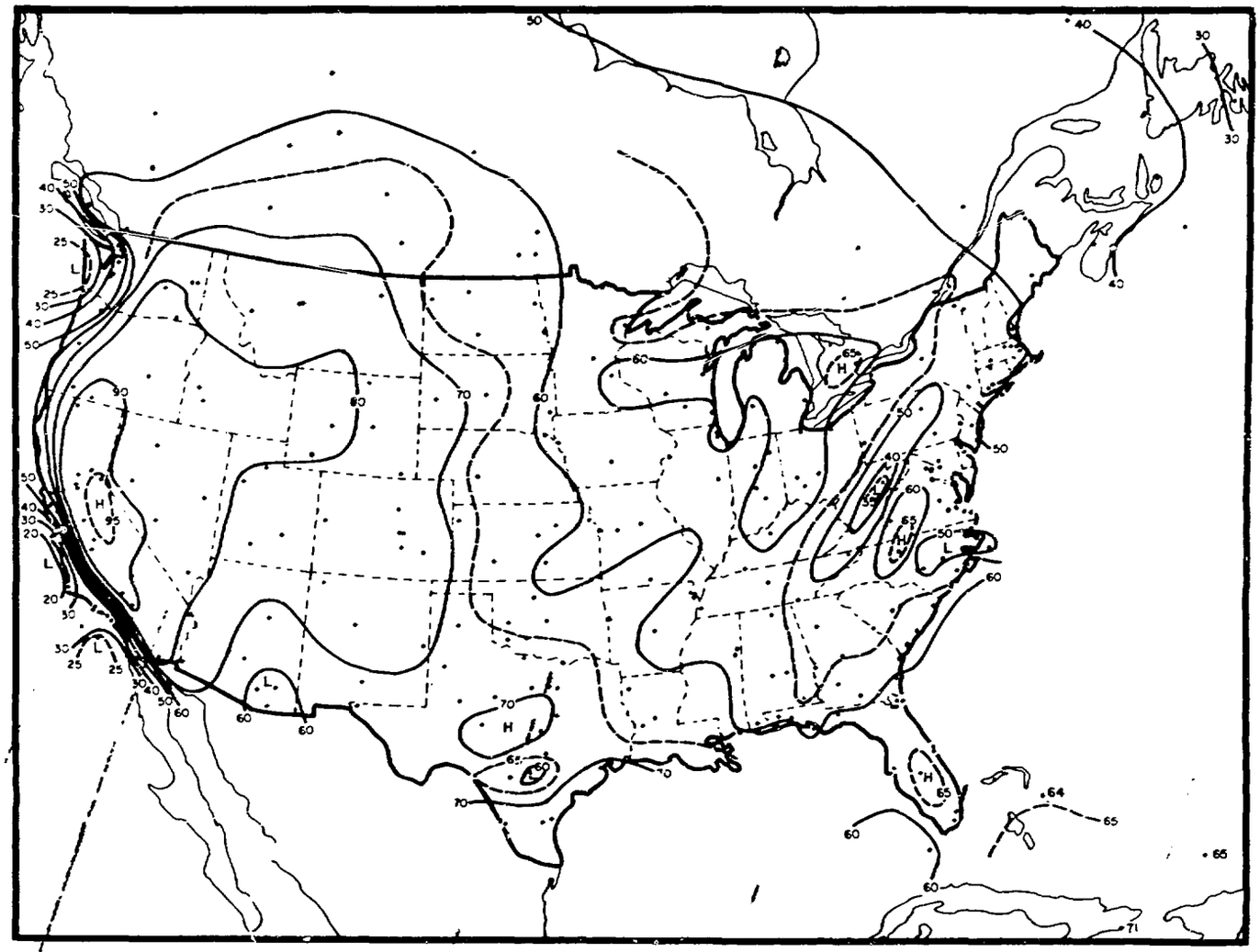

Figure 29. CFLOS Probabilities for July, 0600–0800 LST, 90° Elevation

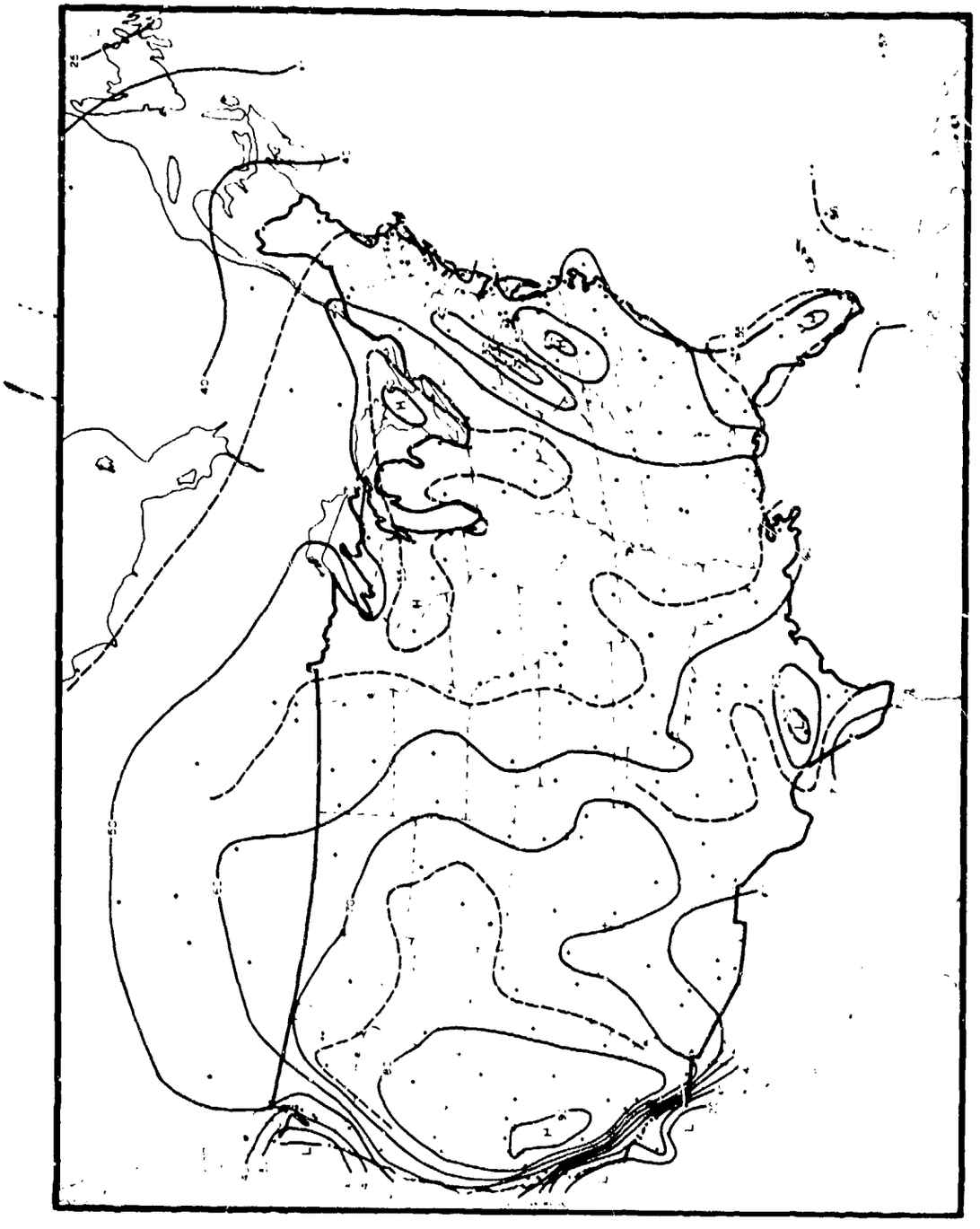

Figure 30. CFLOS Probabilities for July, 0600-0800 LST, 30° Elevation

Figure 31. CFLOS Probabilities for July, 0600-0800 LST, 10° Elevation

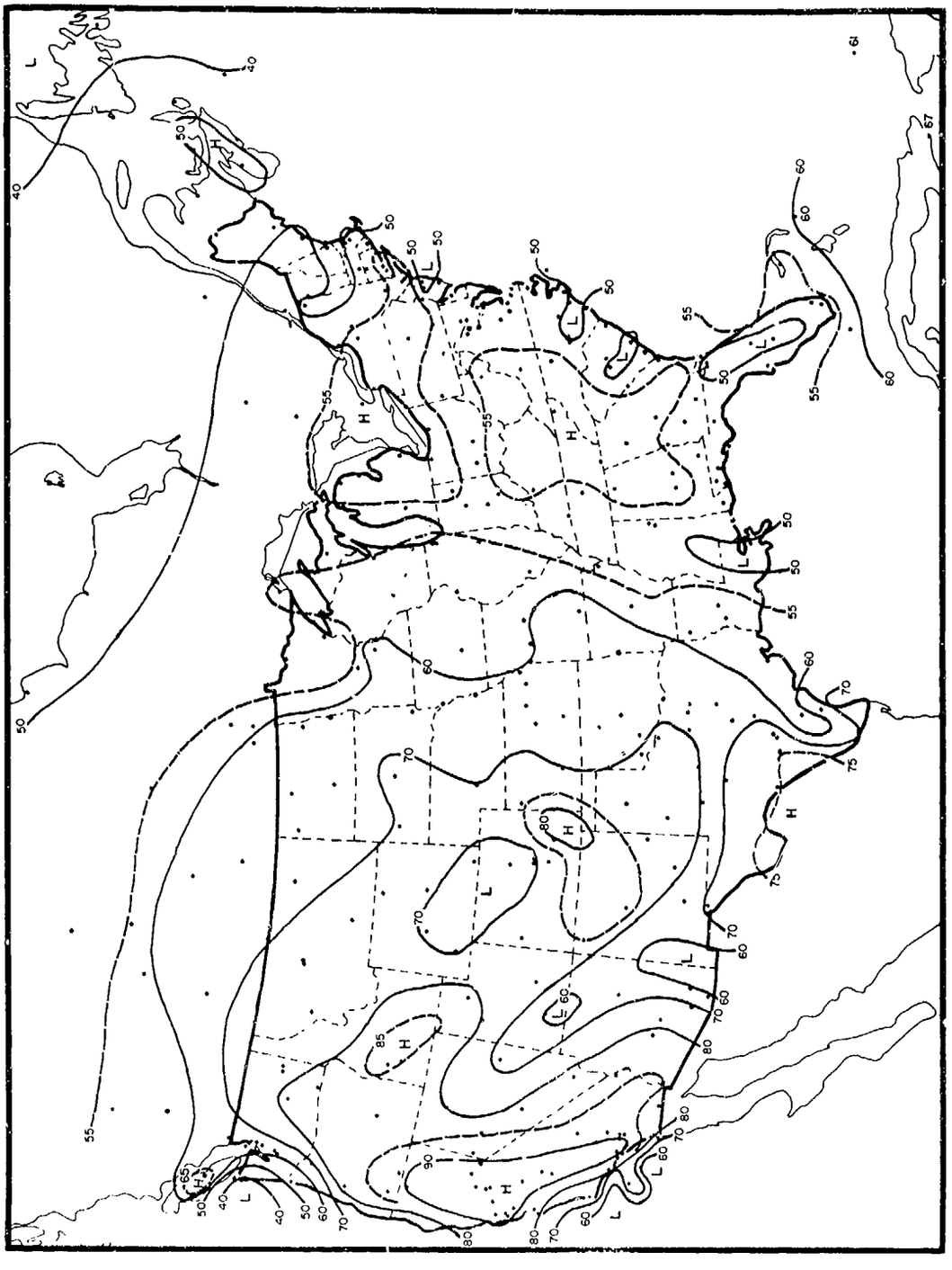

Figure 32. CFLOS Probabilities for July, 1200–1400 LST, 90° Elevation

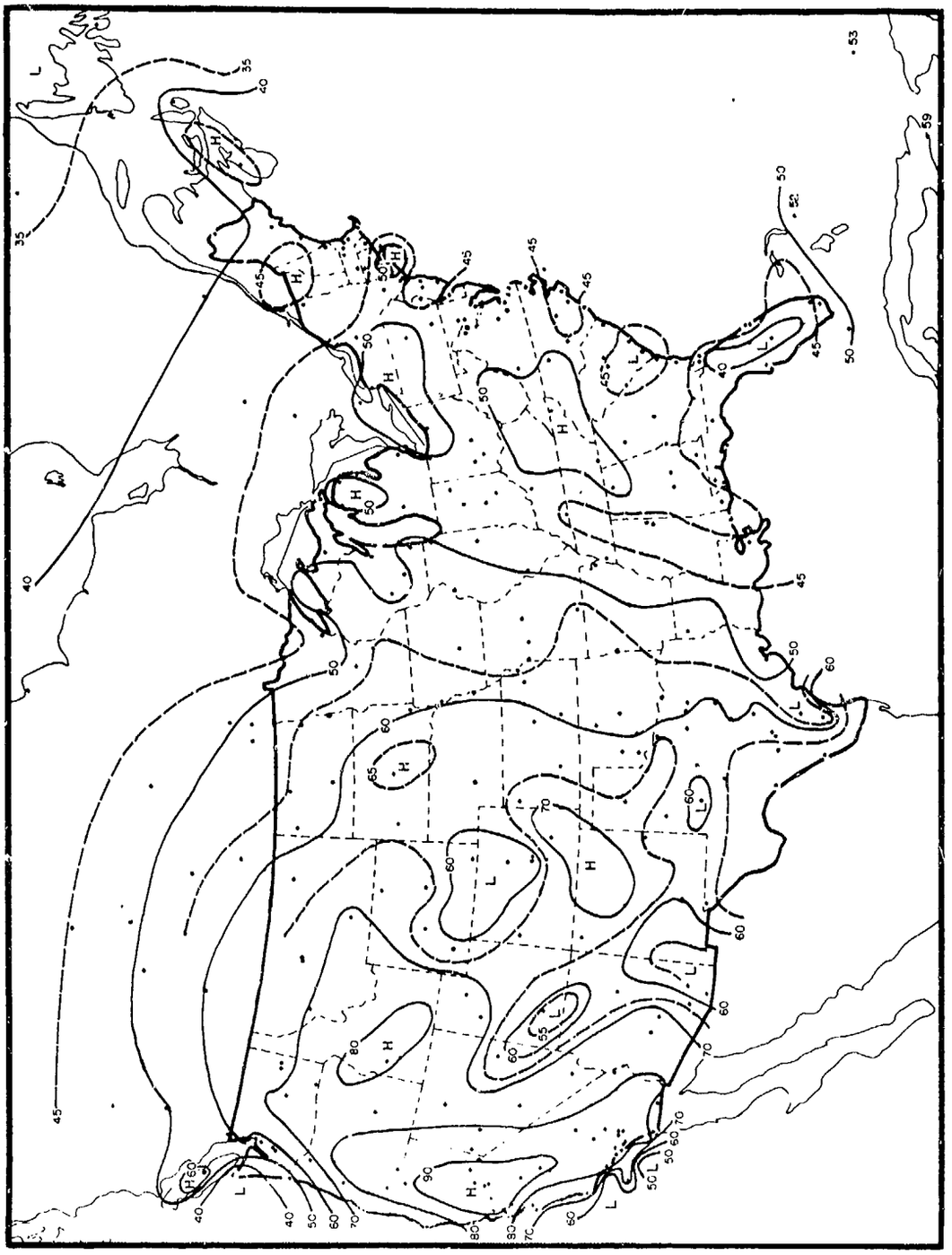

Figure 33. CFLOS Probabilities for July, 1200–1400 LST, 30° Elevation

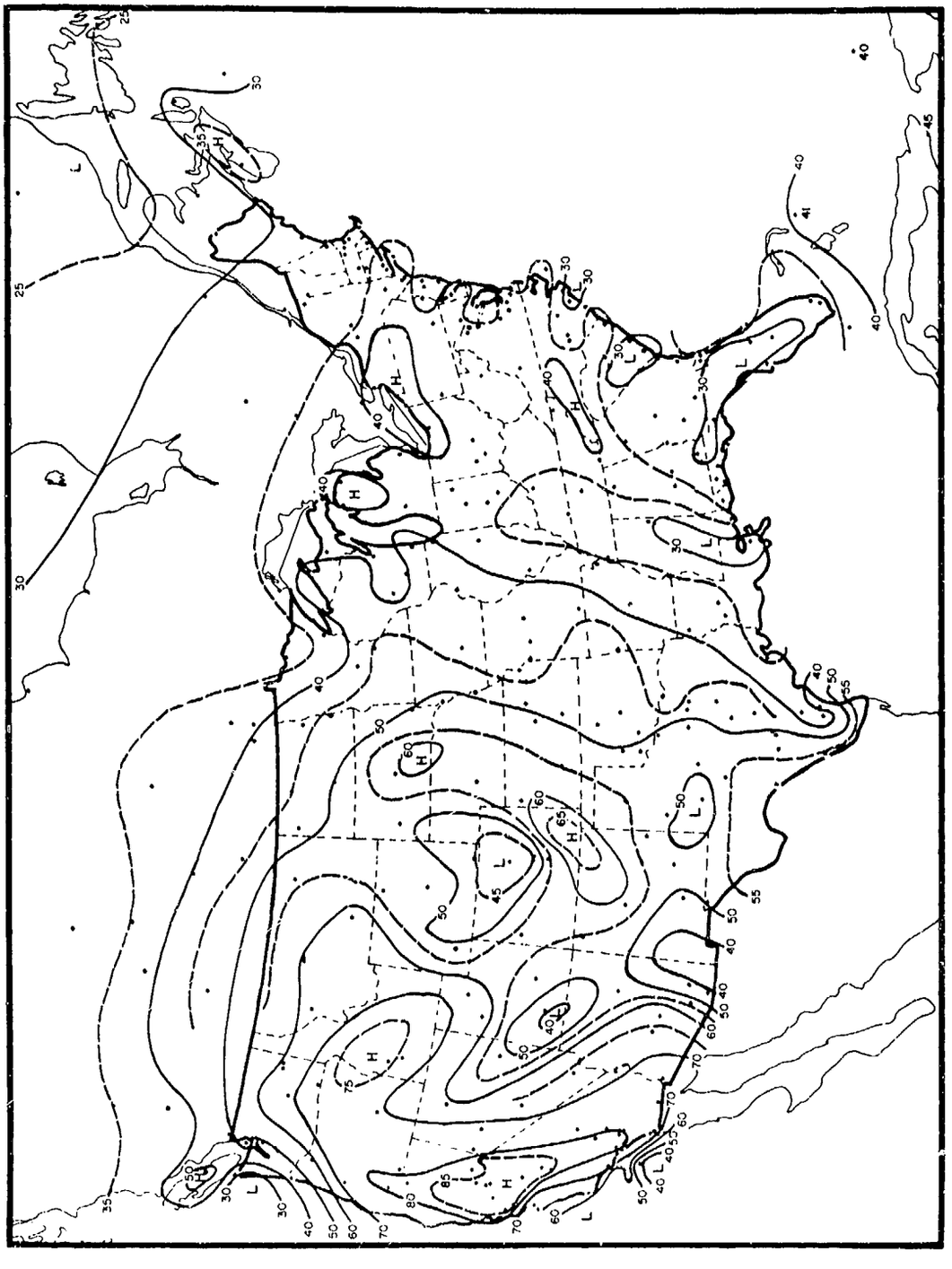

Figure 34. CFLOS Probabilities for July, 1200–1400 LST, 10° Elevation

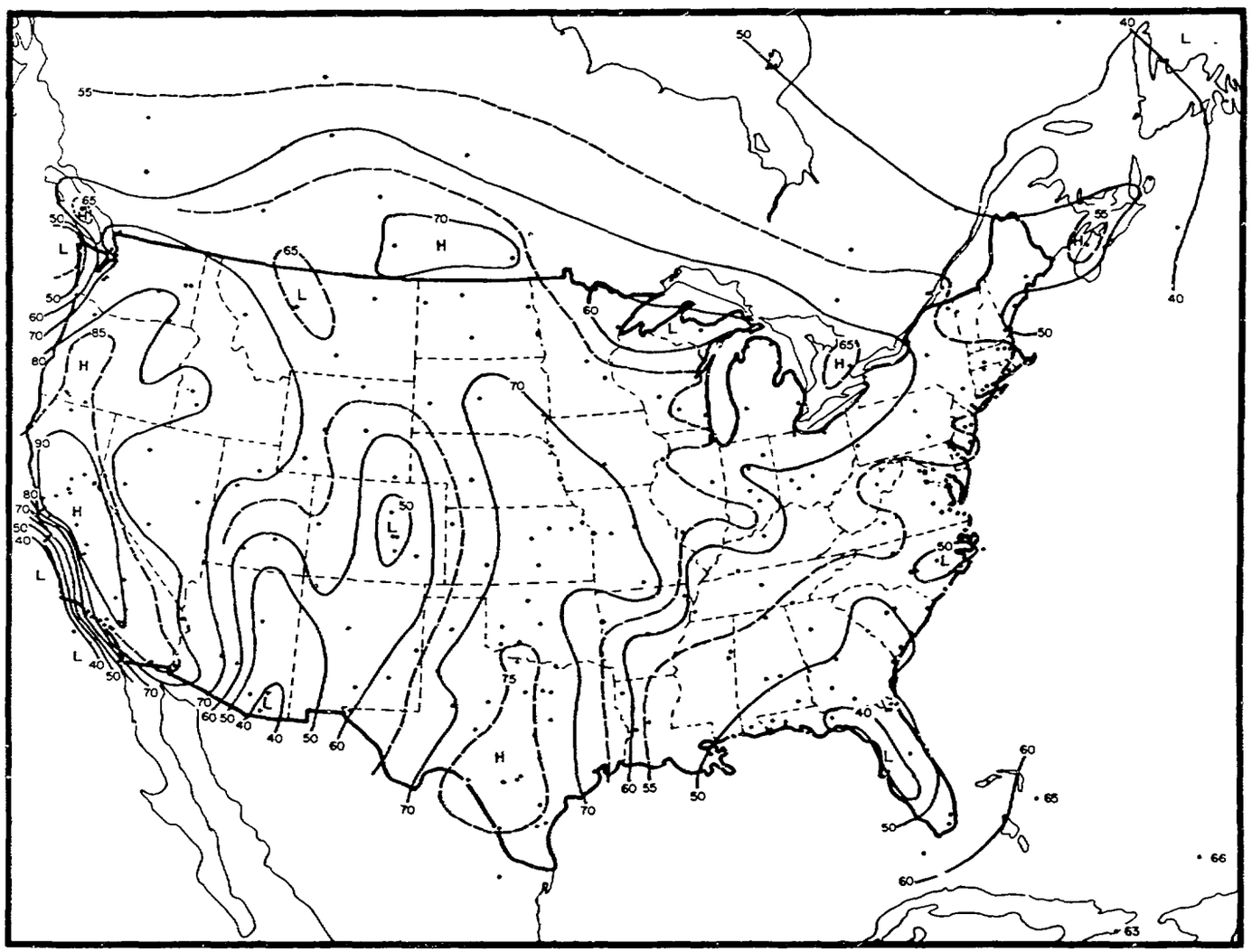

Figure 35. CFLOS Probabilities for July, 1800–2000 LST, 90° Elevation

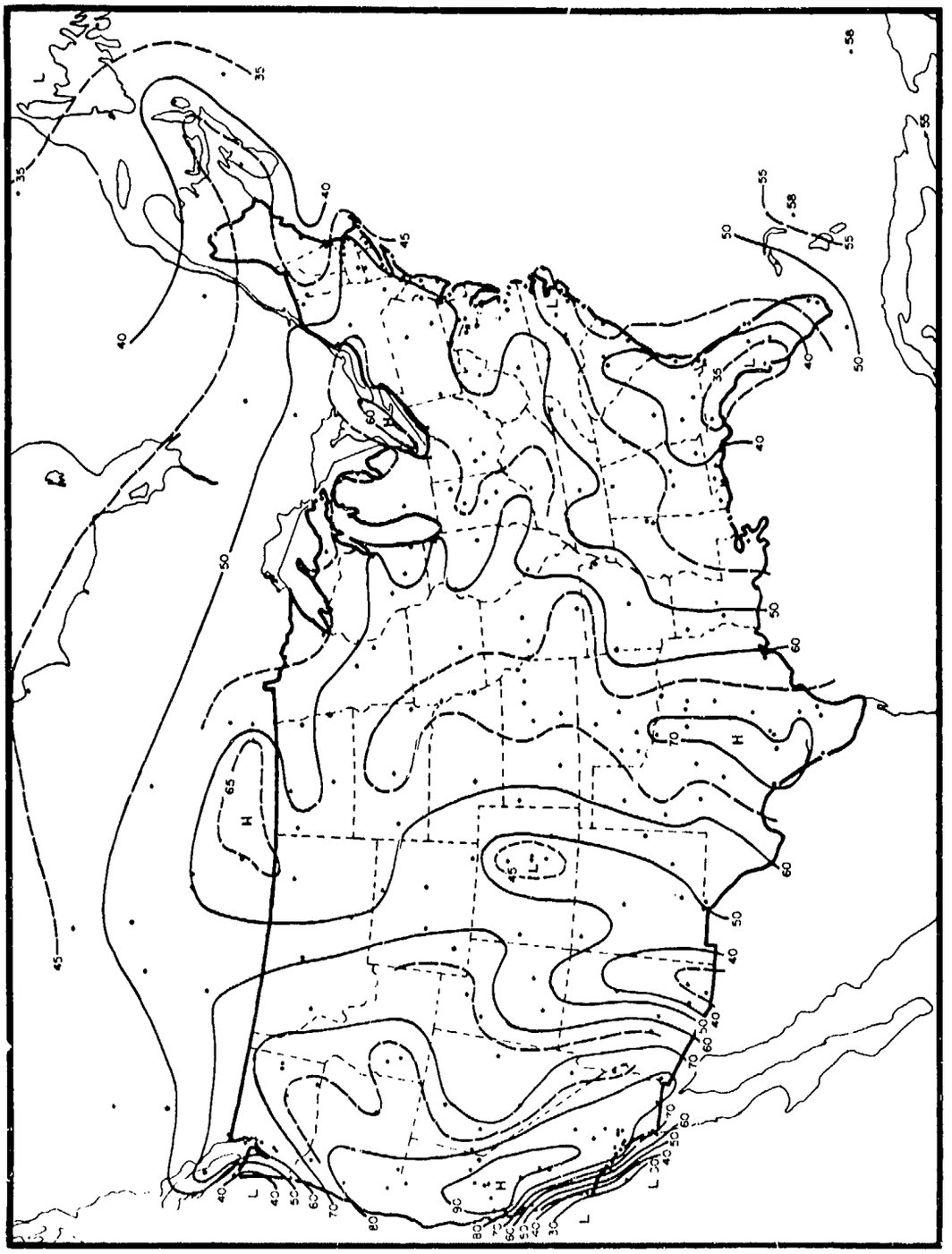

Figure 36. CFLOS Probabilities for July, 1800–2000 LST, 30° Elevation

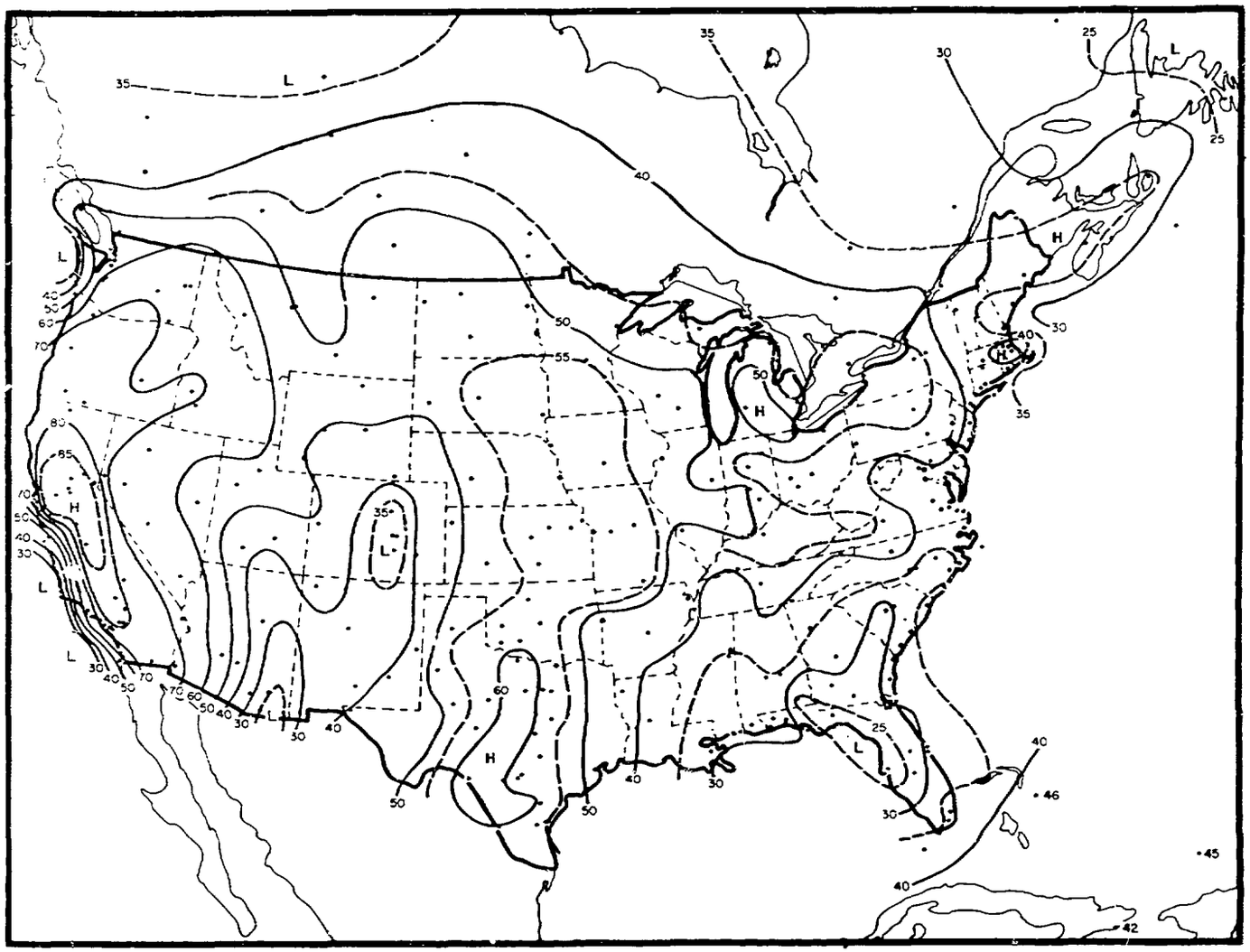

Figure 37. CFLOS Probabilities for July, 1800–2000 LST, 10° Elevation

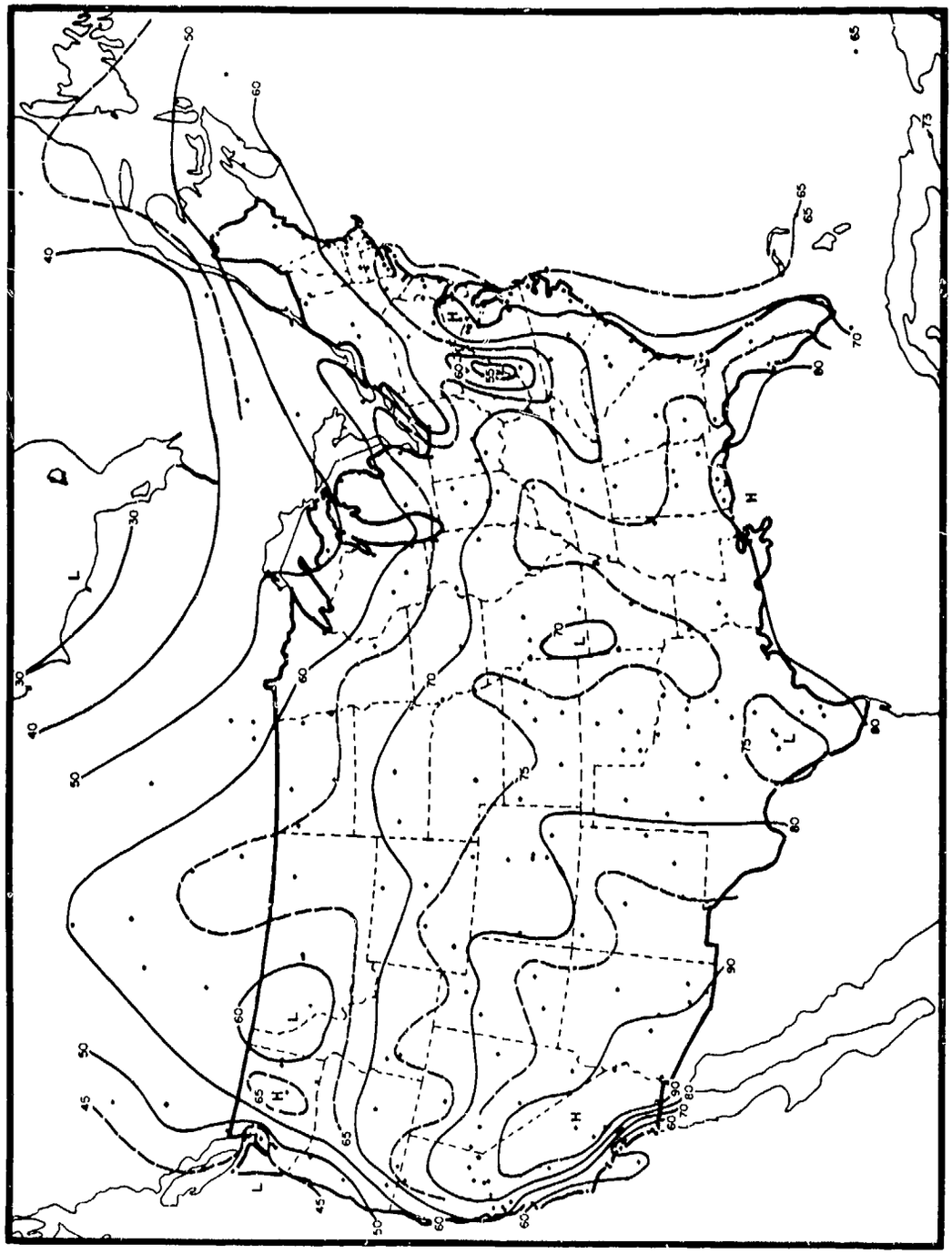

Figure 38. CFLOS Probabilities for Oct, 0001-0200 LST, 90° Elevation

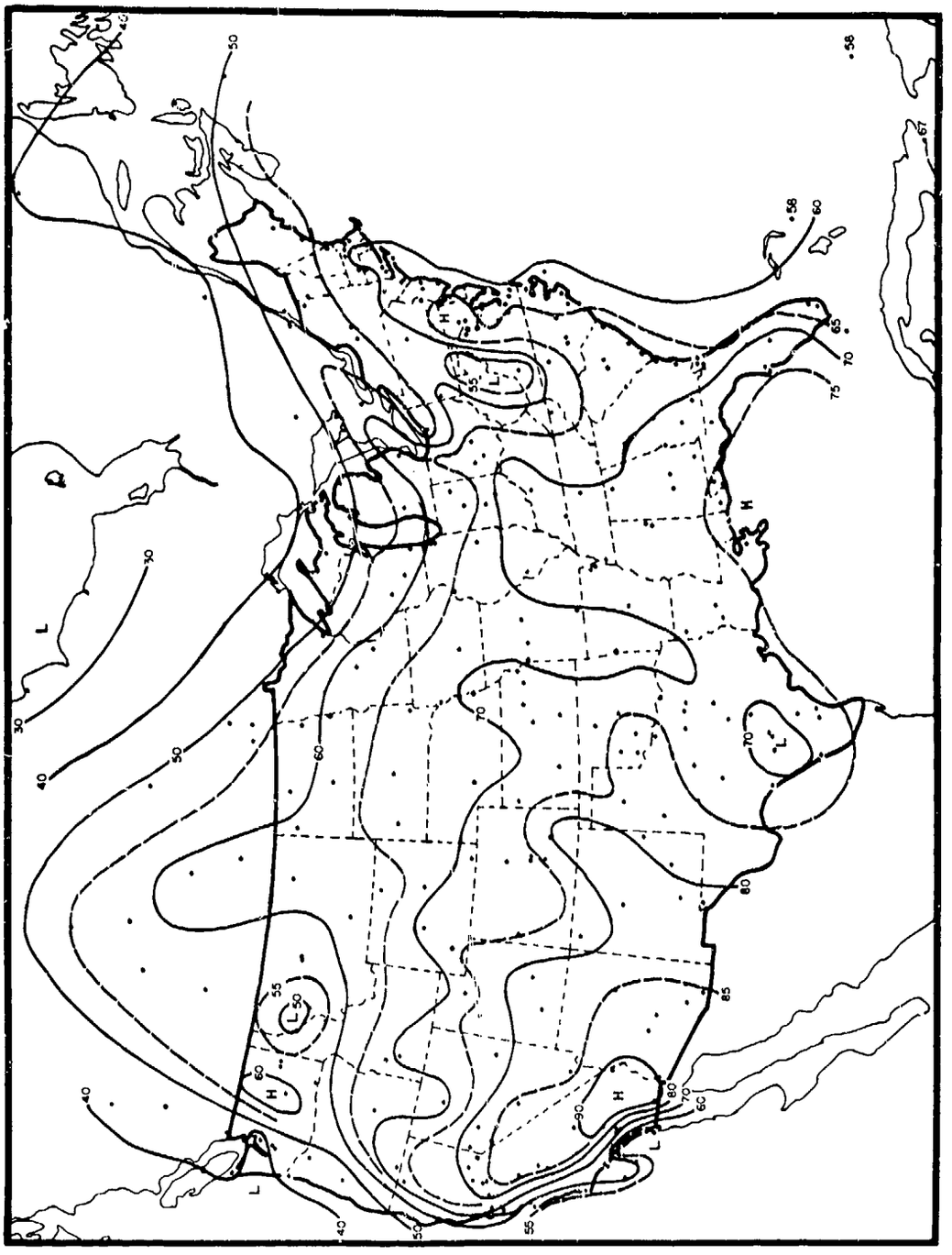

Figure 39. CFLOS Probabilities for Oct, 0000–0200 LST, 30° Elevation

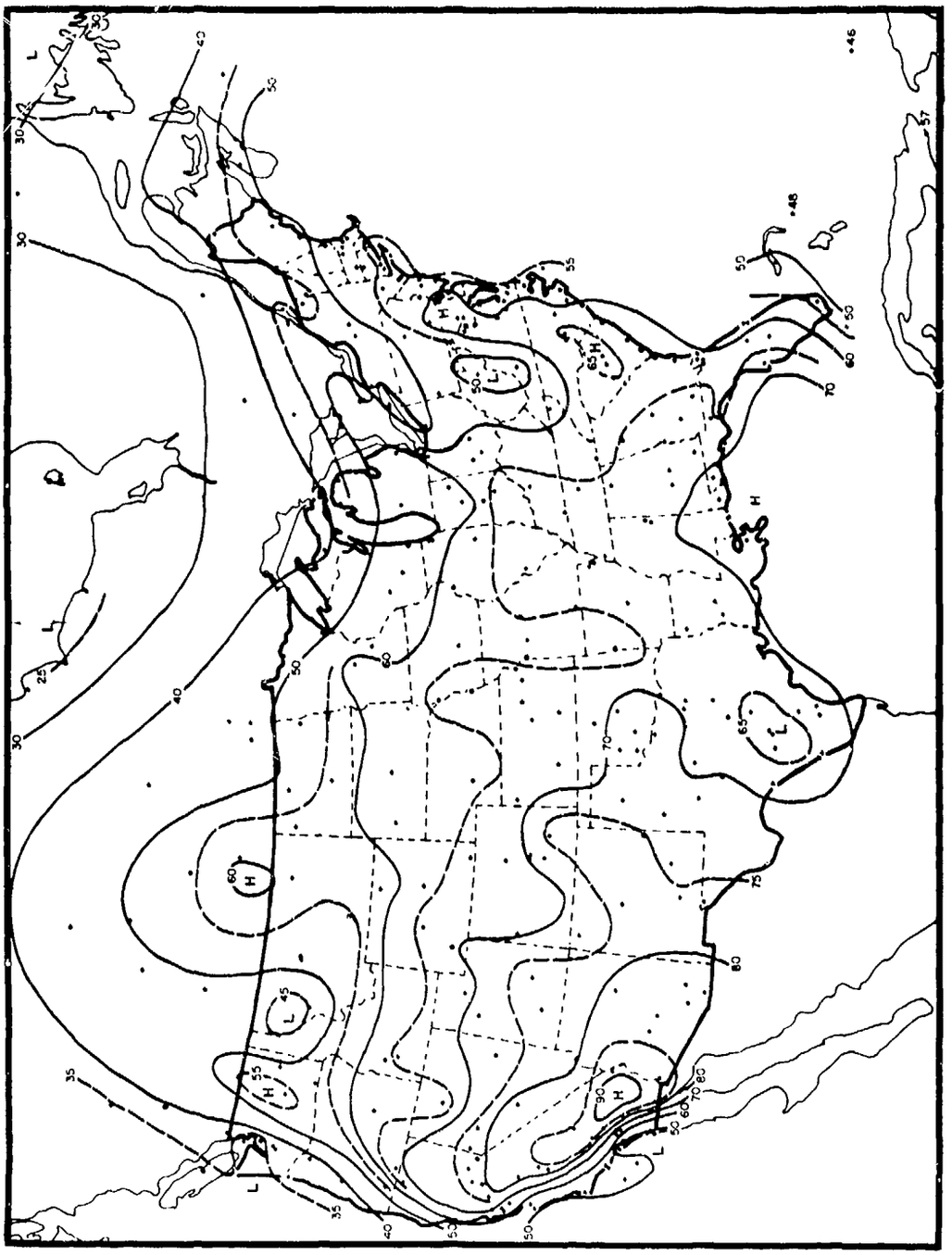

Figure 40. CFLOS Probabilities for Oct, 0000-0200 LST, 10° Elevation

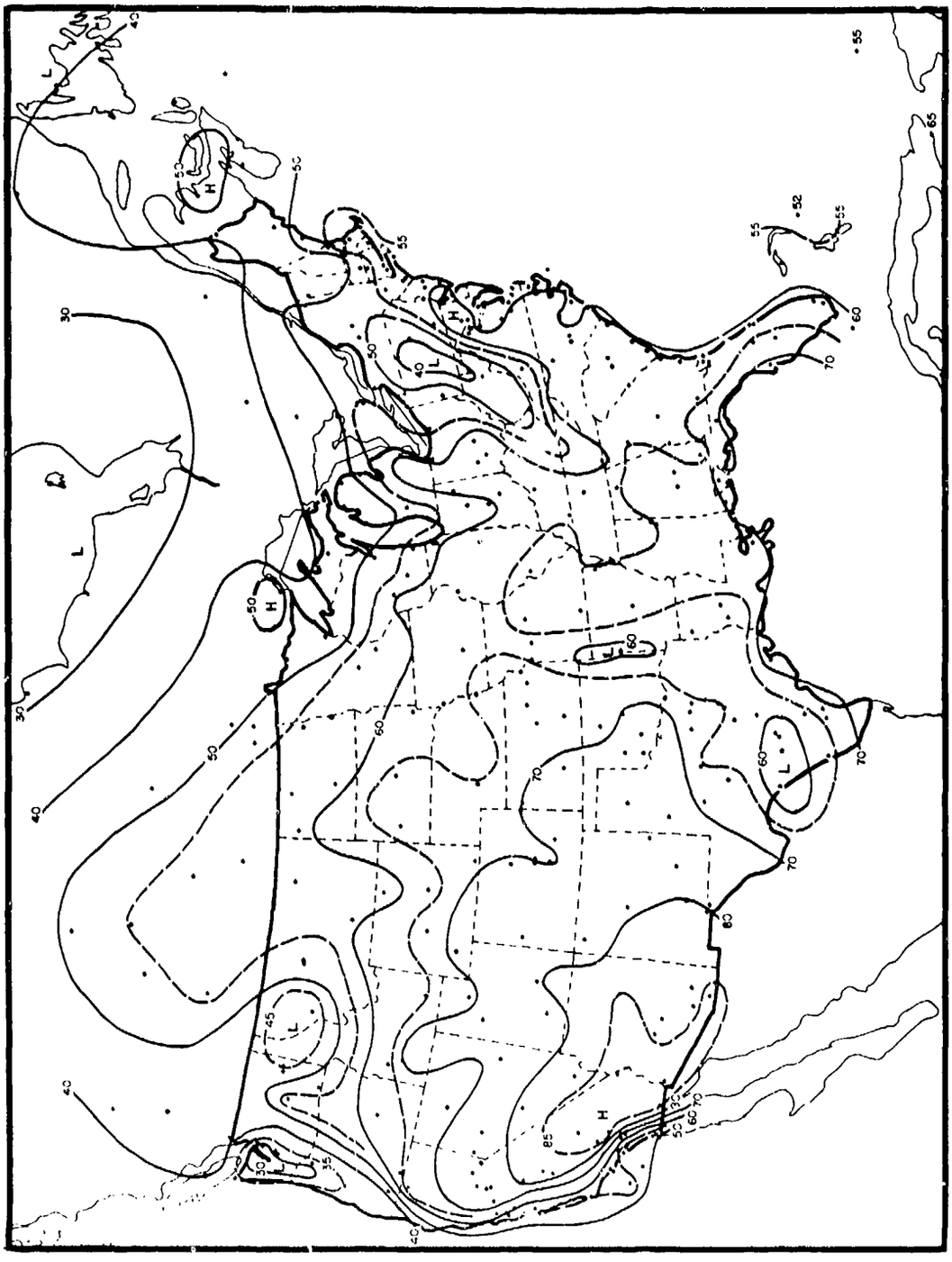

Figure 41. CFLOS Probabilities for Oct, 0600–0800 LST, 90° Elevation

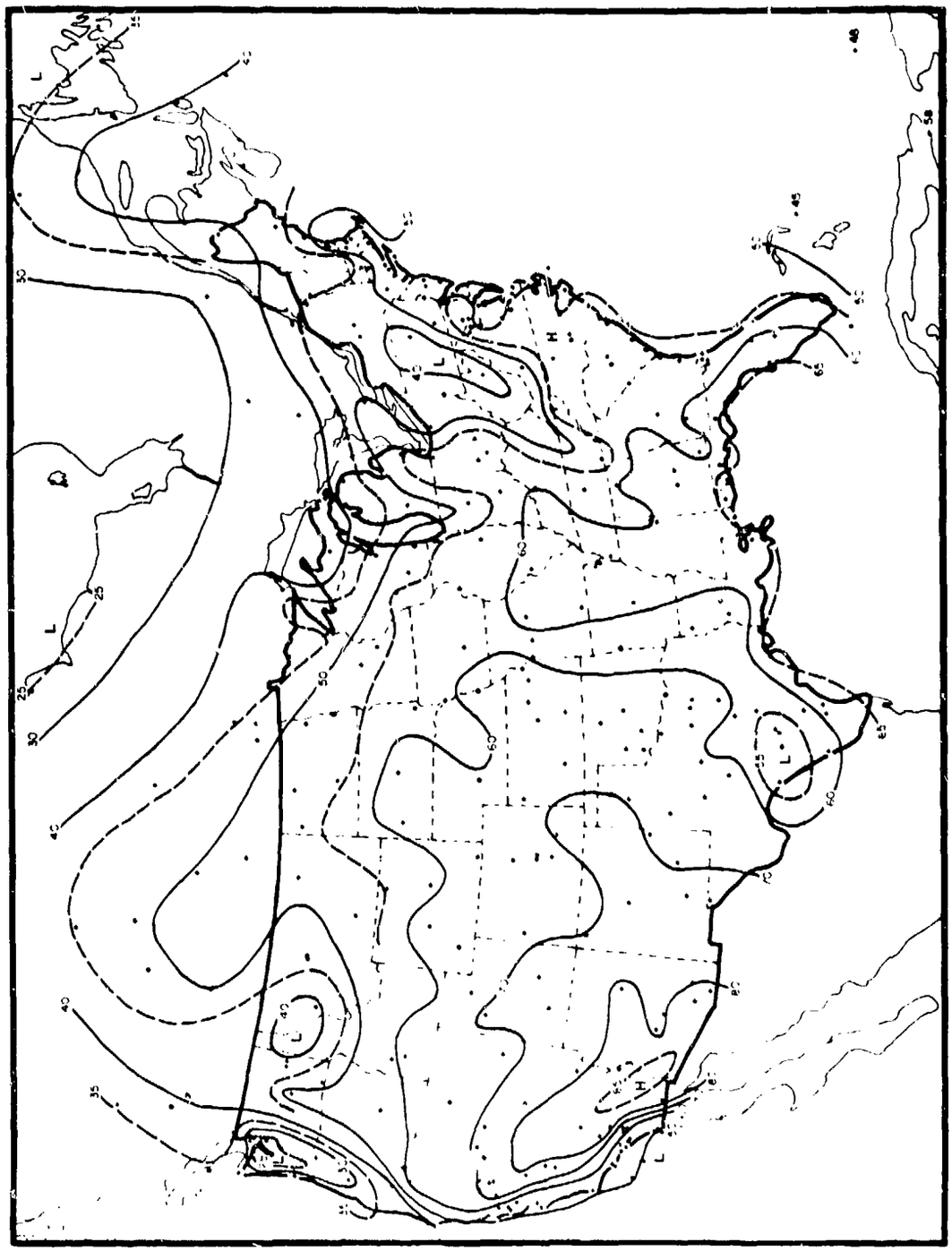

Figure 42. CFLOS Probabilities for Oct, 0600–0800 LST, 30° Elevation

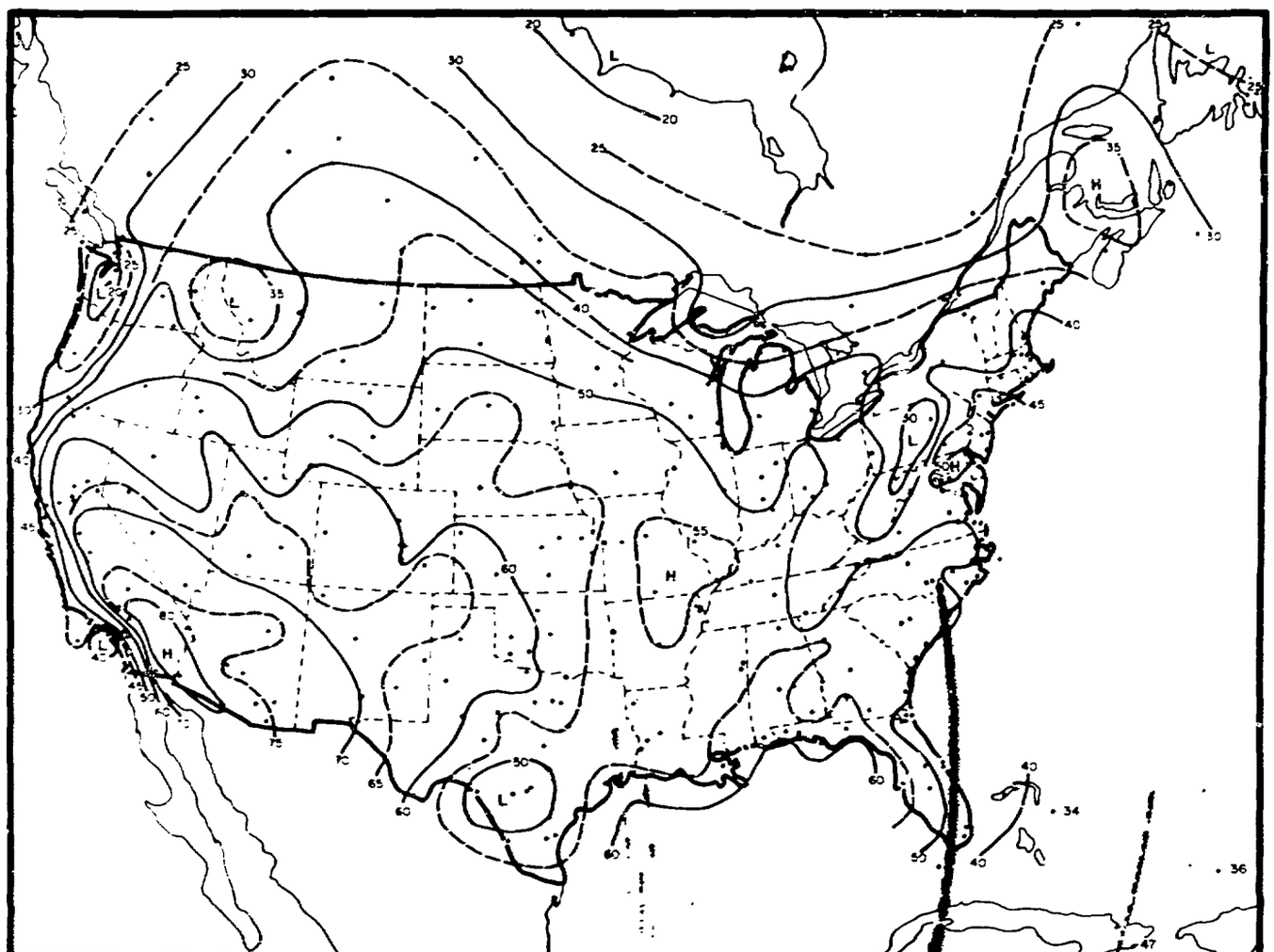

Figure 43. CFLOS Probabilities for Oct, 0600–0800 LST, 0° Elevation

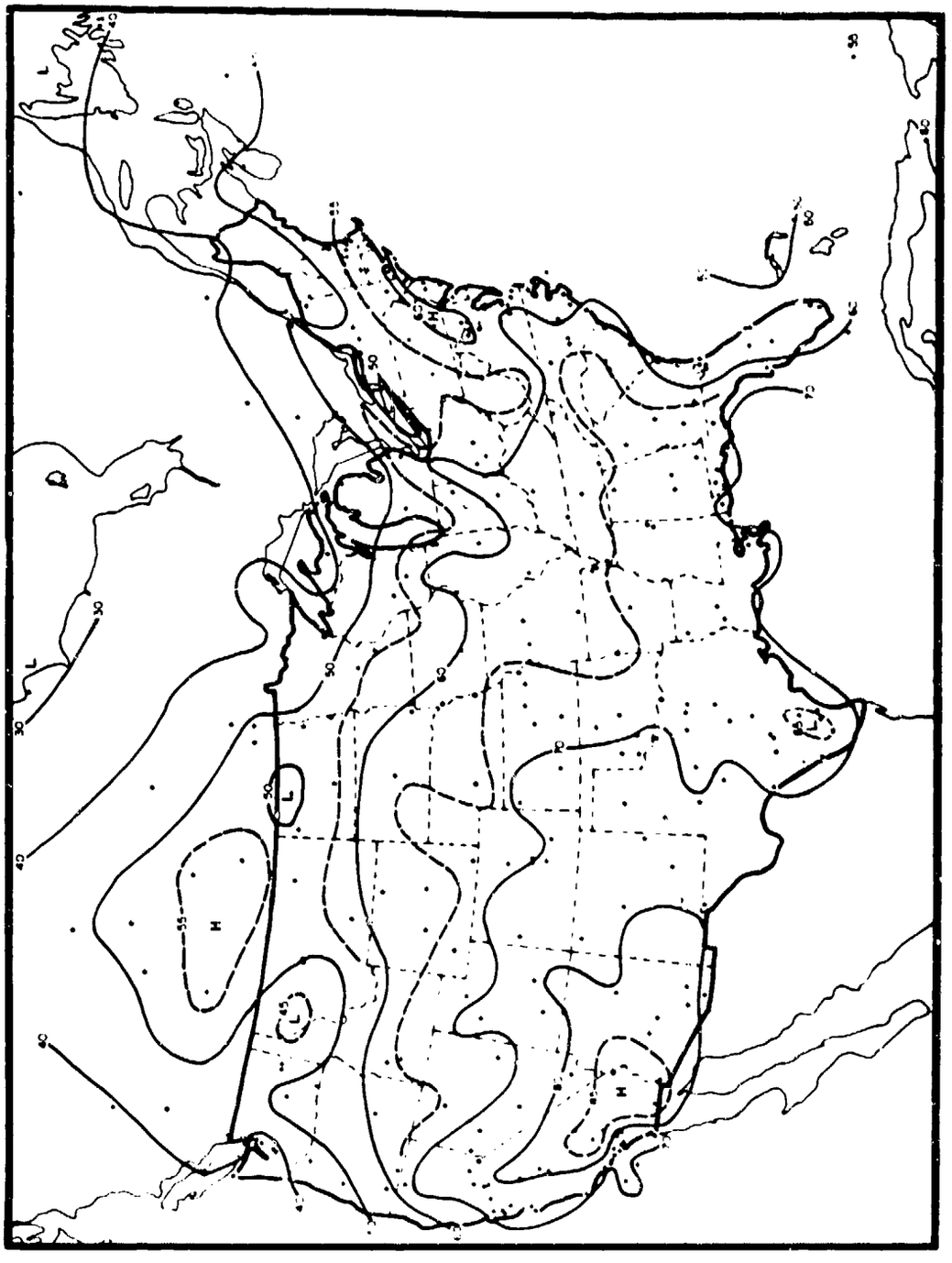

Figure 44. CFLOS Probabilities for Oct, 1200–1400 LST, 80° Elevation

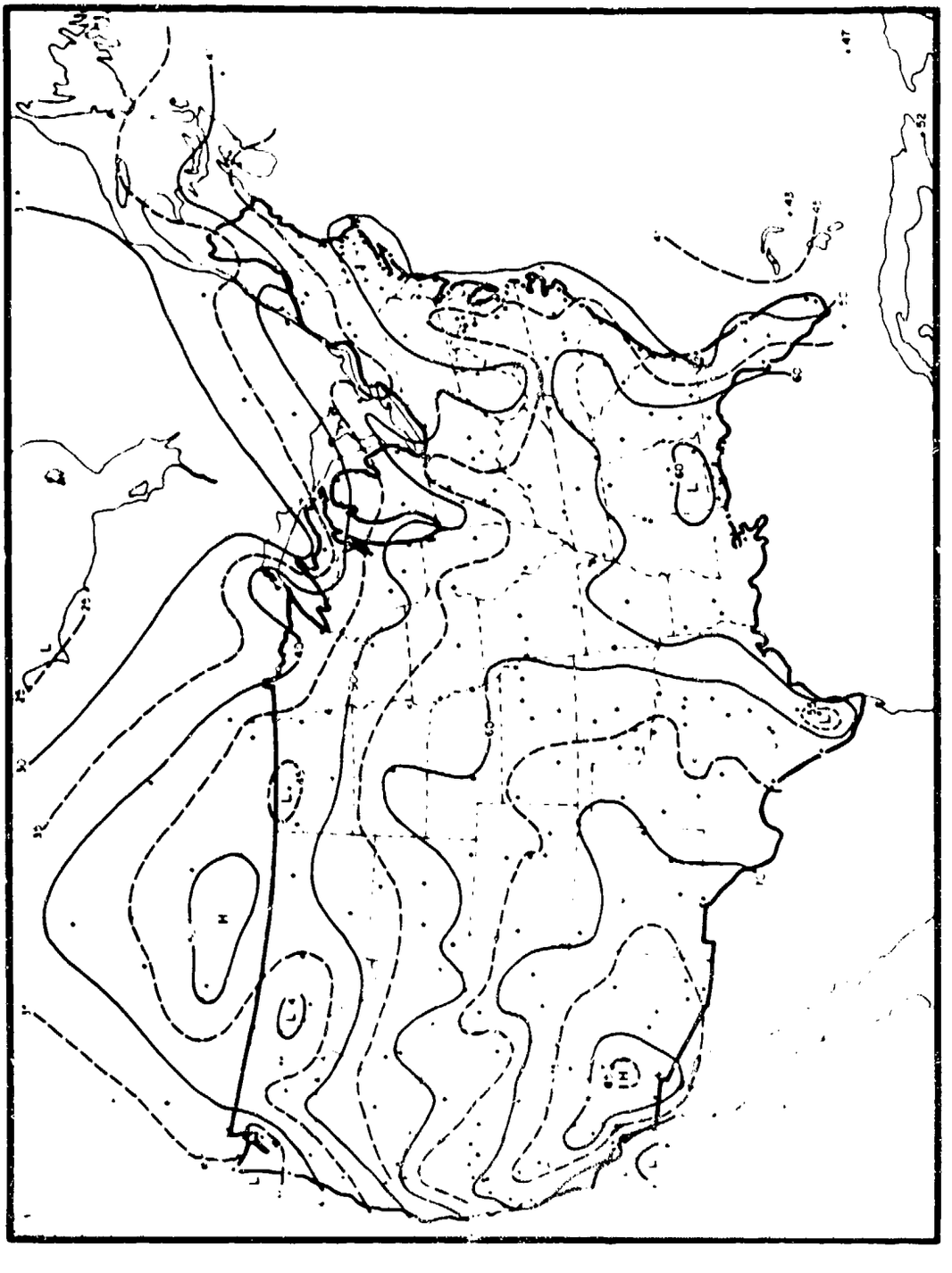

Figure 45. CFLOS Probabilities for Oct, 1200-1400 LST, 30° Elevation

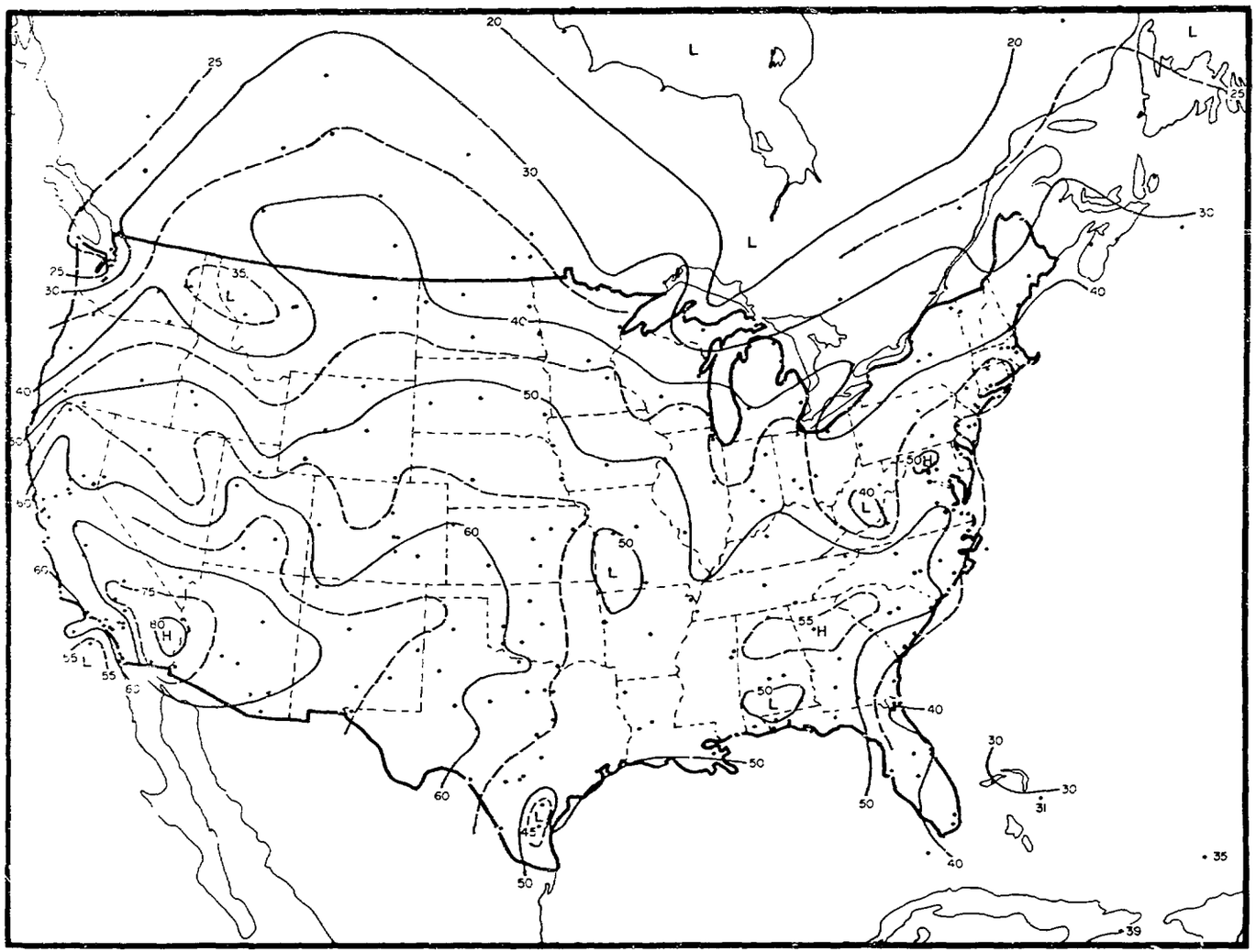

Figure 46. CFLOS Probabilities for Oct, 1200–1400 LST, 10° Elevation

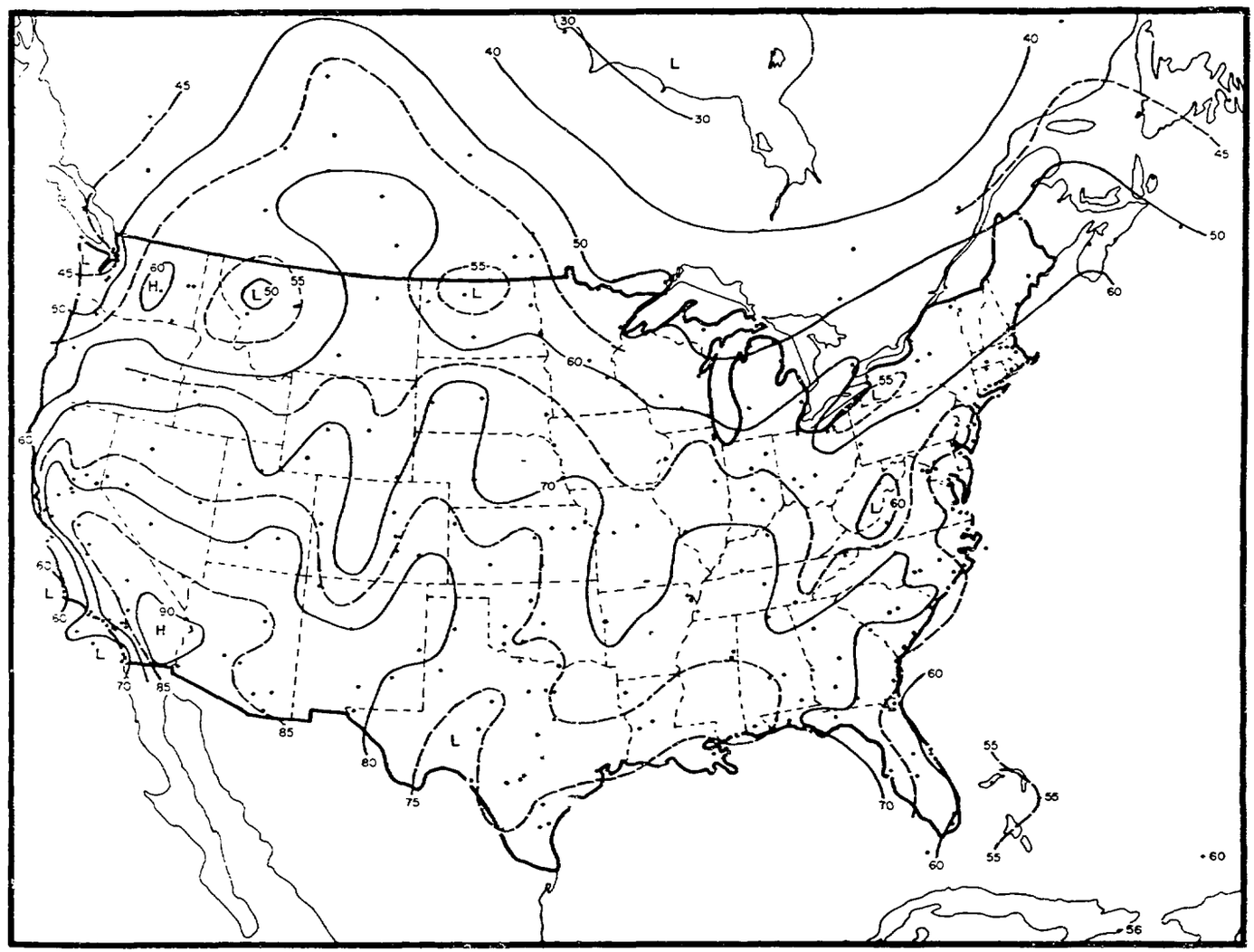

Figure 47. CFLOS Probabilities for Oct, 1800–2000 LST, 90° Elevation

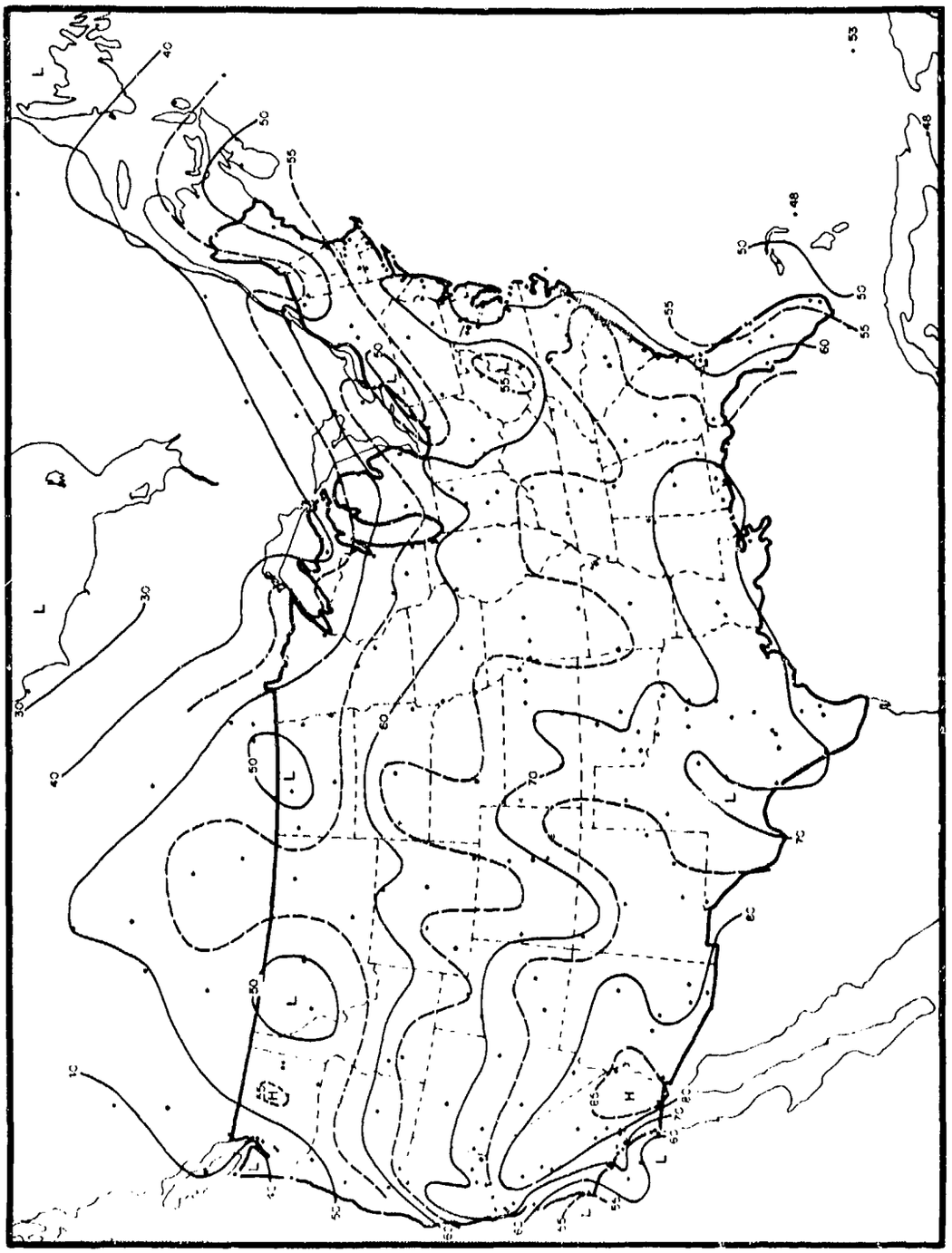

Figure 48. CFLOS Probabilities for Oct, 1800–2000 LST, 30° Elevation

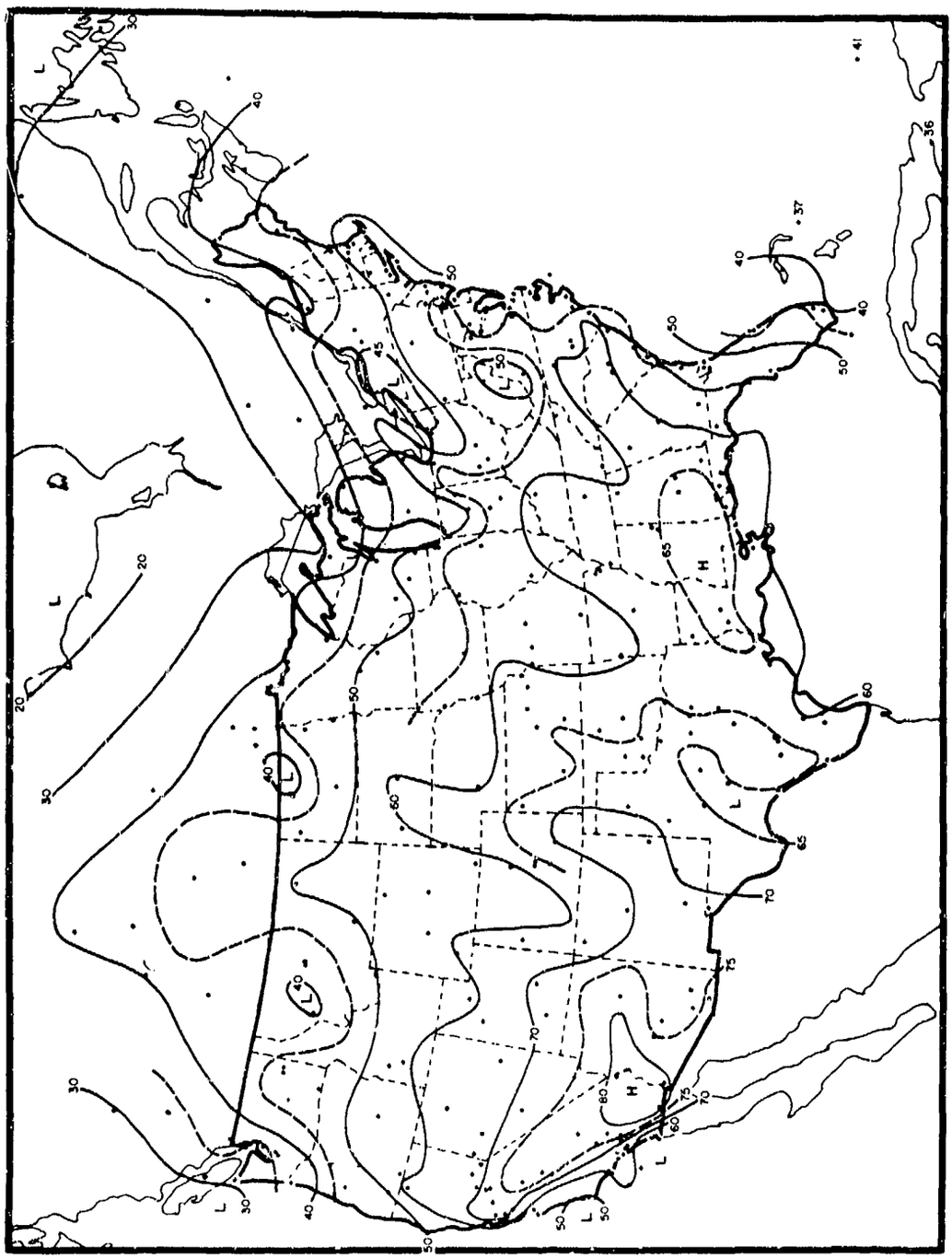

Figure 49. CFLOS Probabilities for Oct, 1800–2000 LST, 10° Elevation

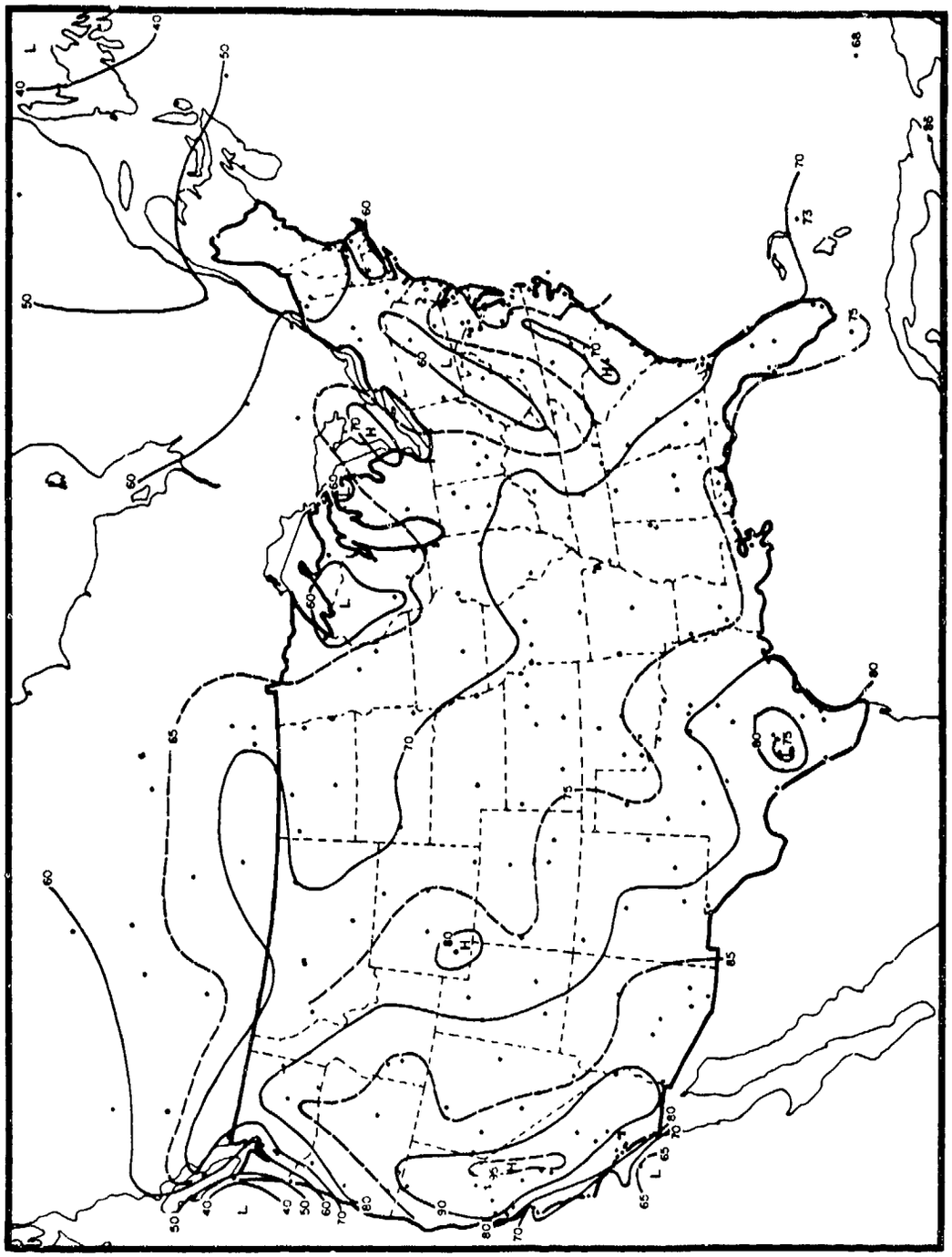

Figure 50. Highest CFLOS Probability, 30° Elevation

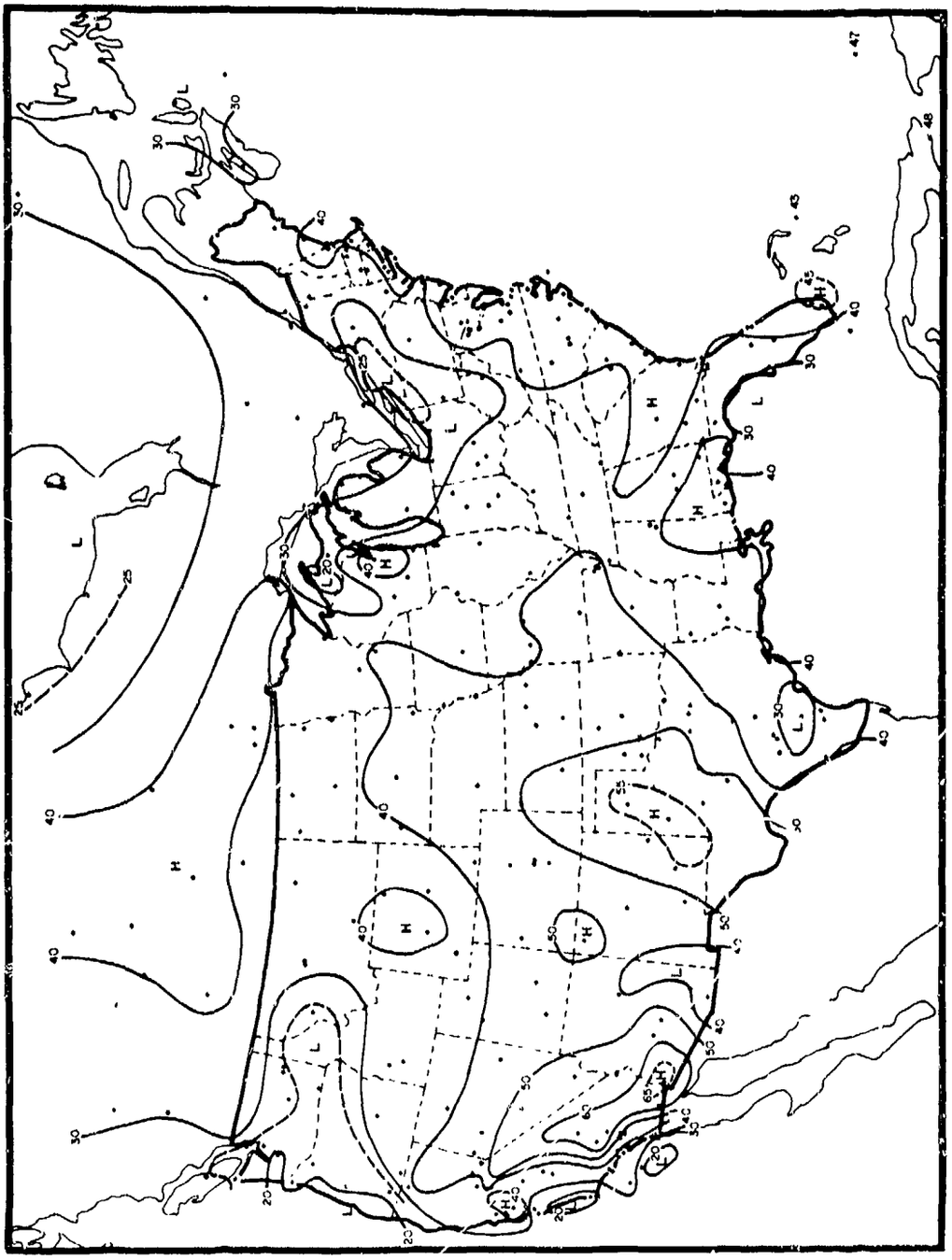

Figure 51. Lowest CFLOS Probability, 30° Elevation